ENGINEERING NEWS

THE NEW CROTON AQUEDUCT COMMISSION, at its last meeting, received several reports from Chief Engineer CHURCH. The first fixes the probable date of completion of the new aqueduct, to its connection with the old mains at 10th Avenue and 135th St., at July 1, 1889, and to the Central Park reservoir at Dec. 31, 1889. For the maximum supply, the figure of 318,000,000 galls. is given, Mr. CHURCH estimates that in 1890 the city will have a population of 1,665,875; and he demonstrates by statistics that the consumption of that year will exhaust the available storage, and the daily supply will be short by 79,600,000 galls. daily. Mr. CHURCH estimates that the cost of the Quaker Bridge dam will be $6,700,000, and it will take 5 years to build it. The Chief Engineer devoted his second report to proving that the conclusions of Engineer MCLEAN, of the Finance Department, were erroneous concerning the Quaker Bridge dam.

THE scattered portions of the great Leary timber raft, abandoned off Nantucket Shoals in December last, are still drifting eastward, and at the present time cannot be far from the rocks of Gibraltar. The residents of the Azores and Madeira islands already report their shores lined with trunks of huge trees which are doubtless from the LEARY raft. Capt. LAWRENCE, of the bark *Platena*, from Huelva, Spain, reports passing on Sept. 4, N lat. 35° long. 18°, great fields of logs adrift. This is the greatest distance to eastward which they have been seen, being directly on the coast of the Madeira islands. The ravages of the teredo worm have rendered the logs of no market value, indicating that the teredo, like his terrestrial prototype, the mosquito, is always on hand for business, even in places where he gets no chance to do any harm in a century. The weight of the barnacles, which have been forming on the log for months has caused them partly to disappear beneath the water, and they are more of a danger than before.

The extent of water covered by these logs may be gathered from the report of the German bark *Bremen*, which was 5 days among the logs, many of them striking the ship, tearing the copper and damaging the rudder. SAMUEL DADNEY, United States Consul at Fayal, Azores, reports that on June 12 a spruce log 40 ft. long drifted ashore. It was roughly sharpened at both ends and was identified as part of the raft.

TO START a European immigrant business *via* the part of New Orleans is a project now being agitated by C. P. ATMORE, General Passenger Agent of the Louisville & Nashville. A meeting was held at Louisville on Oct. 25, of the Passenger Agents of the lines centering at New Orleans, at which the project was discussed. It is proposed to run a weekly line of steamships from Liverpool and adjacent ports to New Orleans, and the only action taken at the meeting was a unanimous motion that the Chairman ascertain from the West Indies and Pacific Steamship Company just what arrangements could be made, and what assistance it would lend toward the project. Such rates by rail would be made by the interested railroads from New Orleans for the emigrants as would be most advantageous for them, such rates to be made only to *bona fide* immigrants.

THE Chicago Elevated Railway contest between rival companies goes bravely on. The MEIG'S and ONDERDONK schemes seem to be finding most favor.

The report that the Onderdonk scheme is in the interest of the Canadian and Northern Pacific is denounced as a hoax. The N. P. has obtained all it needs from the Wisconsin Central, and the C. P. has no intention of going to Chicago unless from the east.

IN connection with the controversy over the location of the St. Clair Flats Canal, Mr. WATSON A. FOX, writes a long letter to the *Buffalo Express* in which, after detailing the inauguration of the project in 1854, he states that the original canal was located with its axis exactly on the boundary line between the U. S. and Canada; and this was done for the express purpose of securing an appropriation from the Canadian Parliament, and $20,000 was so obtained. This neutral channel, 200 ft. wide and 14 ft. deep, was the South Channel, and answered its purpose until 1871, when the United States Government commenced another channel, 400 ft. wide and 16 ft. deep, several hundred feet west of the neutral canal and consequently entirely in American territory, But Mr. FOX also states that the channel in the Detroit river, past Bois Blanc Island, Fort Malden and the Lime Kilns, is almost as important to lake commerce as the St. Clair channel, and though it is entirely in Canadian waters, the United States Government has expended over $600,000 in deepening and widening it.

MAJOR POWELL and his staff are busily engaged in preparing for the survey of the arid regions of the West. The territory to be examined covers 1,300,000 sq. miles, an area about as large as Europe with its 250,000,000 of people. Maj. POWELL says that the selection of sites for reservoirs, canals, etc., rests upon a complete topographical survey of this section. This is the first factor in the solution of the problem, and nothing can be done in the way of improvement until this has been at least approximately completed. A large portion is already surveyed and thirteen parties are being equipped for the special work remaining.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was the derailment of a Chesapeake & Ohio passenger train near Charleston, W. Va., on Oct. 27. The train was derailed on an embankment by an open switch; two of the passenger cars were telescoped and an overturned stove in the baggage car set fire to the wreck, the baggage and passenger cars being burned. Two men were caught in the wreck and burned to death; seven were injured.——On Oct. 19 a Colorado Midland express was "wrecked" (cause not stated) on the Platte river bridge near Spinney. There was a narrow escape from a serious disaster, and about 20 persons were injured, none seriously. ——On Oct. 31 a broken iron rail on the Swedesboro branch of the West Jersey road caused the derailment of 3 passenger cars; no one was injured.

BRIDGE ACCIDENTS are reported as follows:—On Oct. 29, the iron truss highway bridge over the Big Muddy river, near Blairsville, Ill., collapsed while under repair. The accounts are not very clear, but it appears that a rod or counter-rod must have been slackened and the sudden settlement of the structure caused impact strains which resulted in its destruction. The bridge was 170 ft. span and 48 ft. above high water. One man was killed and ten injured, some fatally. The accident seems to have resulted from carelessness or ignorance on the part of the men in charge of the work.——On Oct. 30, the Canadian Pacific Railway bridge near Winnipeg, Manitoba, was injured by fire. The fire was started by incendiaries.

ANOTHER serious break occurred in the Cornwall canal, Canada, on Oct. 28; the embankment that was being built to repair the break reported in our issue of Oct. 20 being carried away, and the break considerably enlarged. It is thought that repairs cannot now be completed before the close of navigation.——On Oct. 29 a large portion of the embankment of the river St. Pierre, which forms a part of the Lachine canal, at Cote St. Paul, about 4 miles from Montreal, gave way, and this break, like the one on the Cornwall canal, can hardly be repaired before navigation is closed. Work is in progress on the repairs.

THE west-bound fast express on the Northern Pacific was wrecked at Crow Wing river Oct. 27. The train was running about 40 miles an hour to make up lost time, and ran into an open switch near the east end of the bridge. The engine broke loose from the tender, and the mail car and 2 baggage cars went over the embankment into the river. The engine, with the engineer and firemen, *crossed the bridge on the ties*, but left them at the west end, tumbled over and half buried itself in the embankment, killing the firemen, and severely injuring the engineer. Only one man was seriously injured on the rest of the train.

The is another of the many cases which weekly occur where rerailing safety guards would have saved a part of the wreck at least, and all the loss of life. Those who persistently neglect such a well established precaution cannot be held guiltless.

A LANDSLIDE occured on the Georgia Southern Railway, 34 miles from Macon, Ga., on Oct. 25, and caused some delay to traffic. It is reported that slides occur at that point after very heavy rains.

TWO EARTHQUAKE shocks, accompanied by a rumbling sound and trembling of the ground, were felt at New Bedford and Fair Haven, Mass., on the night of Oct. 28.

MR. HOEY, of the Adams Express Co. of this country, is now according to English reports, in Europe negotiating for the introduction of the methods of his company in the transport of goods. Mr. HOEY declares that the Adams Co. can beat all the European companies by nearly 24 hours, or *pro rata* on any given distance. Our contemporaries say that the few big carrying companies in England may soon have cause to repent of their absurd system, general inactivity and lack of common courtesy.

THE Union Switch & Signal Co. has arranged to manufacture a new form of car buffer invented by Mr. GEORGE WESTINGHOUSE, Jr., which appears to have important advantages; namely, a device offering resistance to the inward movement of the draw-bar sufficient to absorb in itself the momentum of the load in ordinary working in such a way that shock and consequent injury to the car, will be obviated.

The device in question consists of a cast-iron box containing a number of thin plates secured to it, and a like number of thin plates placed between those in the box and attached to movable pieces against which the draw-bar presses. When the draw-bar is pressed inwardly these thin plates are, by a simple wedge device, clamped or squeezed together so as to offer an immense frictional resistance to further inward movement, which together with the resistance of the main springs (the same as heretofore used,) absorbs such an amount of momentum that it is possible to run one car into another at a speed of 8 or 10 miles an hour without fully exhausting the frictional resistance and compression of the springs.

Not only do the friction plates of the buffer offer an immense resistance, but the reaction of the main springs is prevented, thus assisting to decrease the risk of breaking trains in two.

The apparatus is particularly adapted to use in connection with the Janney type of coupling and is applicable to all classes of cars, freight and passenger. It promises many advantages. The company proposes to manufacture and sell the apparatus, including the right to use, at reasonable rates, but to reserve the manufacture of all of the special apparatus in order to insure uniformity.

THE Union Palace Car Company has been organized by the parties holding the controlling interests in the Mann and the Woodruff Palace Car companies, and interested also in the Harlan & Hollingsworth and Jackson & Sharp companies, and is to place 34 new palace cars on the Richmond & West Point Terminal system at once. It is supposed that the new company intends to make a strong fight for territory against the Wagner and the Pullman companies.

M. JULES VERNE has let loose his fertile imagination upon the subject of a submarine railway between England and America, and pictures such a line of communication with all its detail of number of tubes, weight of the same and the puzzling differences in time. It is a good story; but like the same author's "Trip to the Moon" it embodies engineering that reads well in a novel, but would hardly do for present practice; at least, with present light.

A NEW great lake has been discovered in the interior of the "dark continent", extending from 2° 20′ N to 5° N, or about 200 miles, and nearly as wide as it is long. The report shows how little is still known of interior Africa.

A NEW thing in mileage tickets is a 5,000 mile ticket issued by the Lake Shore & Michigan Southern company and good for passage on about 25 lines besides their own system. The ticket will be of especial advantage to commercial travellers. It is stated that the Chicago & Northwestern will soon place a similar ticket on sale good on the principal systems west of Chicago.

The Construction of a Skew or Spiral Arch.

BY M. P. PARET, DIV. ENG. C. & R. R. R. *

(*Concluded from page 321.*)

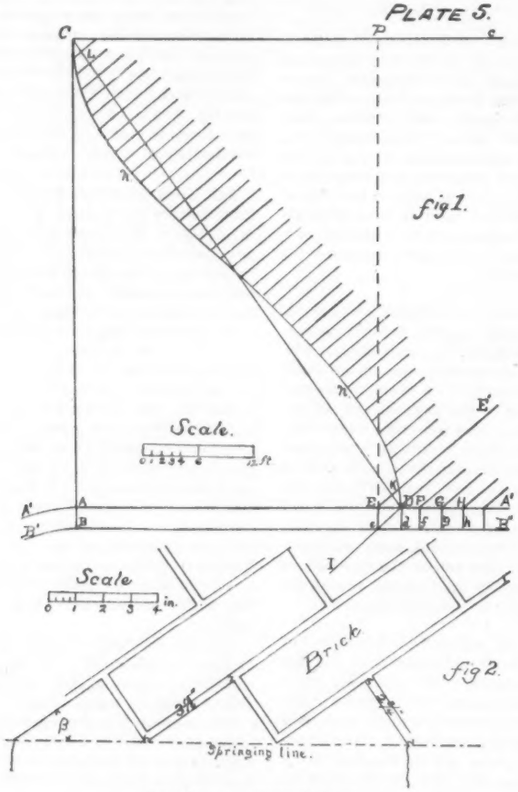
In cutting the ring stone the following moulds and rules were used in addition to the patterns already described. A pair of twisting rules made thus: of half-inch hard wood one rule 2 ft. 2 ins. long and 3 ins. wide, another 2 ft. 2 ins. long, 3 ins. wide at one end, and 5⅝ ins. at the other; these were framed together with round steel rods, so that the equal ends should be 3 ft. apart and the unequal ends 3 ft. $1\frac{13}{16}$ ins. apart, see Plate No. 6, Fig. 2. There should be play enough in the fastenings to allow the rules to move up and down until either their top or bottom are in the same plane or out of wind. The distance apart, 3 ft., of the equal ends is an arbitrary distance, the distance at the back, 3 ft. $1\frac{13}{16}$ ins. is obtained thus: by calculation the angle of the extrados $A'' E E' = \Phi = 38° 45' 30''$, see Plate No. 5, Fig. 1.

$$(3)\quad \frac{sec\ \Phi \cos(\Phi - \beta)}{sec\ \beta} = 3 \text{ ft. } 1\tfrac{13}{16} \text{ ins.}$$

The extra width 2⅝ ins. of the second twisting rule $= (3 \text{ ft. } 1\frac{13}{16} \text{ ins.}) \tan(\Phi - \beta)$. Facing the arch the acute angle is to the left and the spiral runs over the arch from left to right, in other words the winding bed of the stone raises behind, or the rule which is 5⅛ in. at the extrados must be on the left when you stand facing the soffit of the stone.

The twisting rules are used to cut the first bed, thus: lay them on the stone with equal ends facing the soffit, run a level draft along the length of the bed at the soffit and another at right angles to it, in which set the straight edge $A\ B$ sink a corresponding draft under $C\ D$ until the tops of the rule are out of wind, take off the twisting rules and cut the rest of the bed until a straight edge laid parallel to the soffit fits the two drafts already cut for the full depth of the stone. Next, of ¾ in. stuff cut a template, see Plate No. 7, Fig. 4, about 6 ins. wide and 6 ft. long, with lower edge straight and upper edge to a curve found thus: multiply 6 ft. by $\sin \beta$, take the result as a chord of a curve of 14 ft. radius, calculate the middle ordinate, lay this off as the middle ordinate to the 6 ft. curve; to get intermediate points multiply ($\frac{1}{12}$) 6 ft. $\sin \beta$, etc. This gives the same curve as $A\ B\ D$, see Plate No. 6, Fig. 1. Lay this template on the bed of stone already cut, close to the soffit as possible for the length of stone required, run a draft or arris along the soffit to the line so obtained; this completes the bed, and from it the soffit is cut by means of a mould, see Plate No. 6, Fig. 3, made thus use ¾ in. well seasoned hard wood, make two templates, see Plate No. 7, Fig. 5, the arm $D\ B$ 2 ft. 2 in. long, and each edge on the radius extended, $B\ A$ has the lower edge straight and the upper cut to a curve of 14 ft. radius, the curved portion being 1 ft. 8 in. long.

PLATE 5.



Drafting a Spiral Arch.

These templates are framed together as shown on Plate No. 6, Fig. 3. $C\ E$, $I\ H$ and $B\ G$ have all their edges straight, $C\ E$ being 3 ft. 6 in. long, $B\ G$ and $I\ H$ 2 ft. 4¾ in. long, $C\ E$ and $B\ G$ 2 in. wide, and $I\ H$ 2⅝ in. wide. The length of $B\ G = H\ I = C\ D$ is obtained by using $B\ C = 1$ ft. 10 in. and making the angle $B\ D\ C = \beta$. The piece $B\ D$ is 2 in. wide bent down over $I\ H$ and fitting neat with the radial edges of $A\ B$ and $D\ F$. $C\ K$, or the perpendicular distance from C to $B\ D = 16\frac{1}{16}$ in. = thickness of a ring stone (includes joint); $c\ c$ are iron knee braces to stiffen the frame. It is important that this mould should be framed together in the most substantial manner and also accurately. Next cut two templates, see Plate No. 7, Fig. 3, ¾ in. thick, 6 ft. long, the bottom straight and top to a curve with radius of 14 ft., scribe a line on each side at the center and perpendicular to the bottom, apply the mould, see Plate No. 6, Fig. 3, to the bed already cut, with the arms $A\ B$ and $D\ F$ on that bed, and the portion $B\ C\ D$ against the soffit, sink drafts in the soffit until $B\ C$, $I\ K$ and $C\ D$ coincide with them; in the draft cut to $B\ C$, place one of the templates, Fig. 3, so that its center is on the draft line $C\ D$, place the other similar templates parallel to the first at a convenient distance from it and its center also on the draft line $C\ D$, sink a draft for this till it just touches the soffit arris and is out of wind with the first template. Remove the templates and cut the rest of the bed until a straight edge applied parallel to $C\ D$ fits the two drafts and the bed throughout. The other bed is either cut by reversing the mould or by gauging the thickness of the stone; the stone cutters will prefer to gauge the stone. This thickness of the stone at the extrados is obtained thus: see Plate No. 5, Fig. 1, in which $B\ B''$ is the springing line produced at the intrados, $A\ A''$ the same for the extrados, $D\ C$ is the development of an extradosal heading spiral, and $D\ n\ n\ C$ is the development of the extradosal ellipse in the face $D\ I$; $E\ E'$ is the development of the extradosal coursing spiral, and is in the same spiral surface with the intradosal spiral $C\ E'$ (see Plate No. 4;) $E\ E'$ intersects $D\ C$ at K; to determine the distance $D\ K$ in the triangle $A\ D\ C$ we have known $A\ C$ and $A\ D$ from which we obtain the angle $A\ D\ C$, the distance $D\ E = E\ c\ cot\ \phi$. $C\ c$ and $E\ E'$ intersect at some point R, (not shown,) and in the triangle $E\ P\ R$ we know $E\ P$ and $P\ R$, and finding the angle $E\ E\ P$ or its compliment $D\ E\ K$, solve the triangle $D\ K\ E$ for $D\ K$; lay off $C\ L = A\ D$, divide $K\ L$ into the same number of equal parts into which $C\ D$ (see Plate No. 4) was divided, one of these parts equals the thickness of the ring stone at the extrados, equals $18\frac{1}{16}$ in.

Now the two beds and soffit being cut, set the shifting stock to the required angles and apply to the beds, pitch off the face and run drafts to suit; the face patterns were not applied directly as the face of the stone was left rough, but dimensions were scaled from the floor and direct measurements applied. That the creepers over the ring stone in the face may have a level bed, the ring stone must be squared back from the face drafts. Care must be taken in the acute stones to give the creeper as much bearing as possible without weakening the ring stones. The ring stones were set with lewis-bolts to avoid putting dog holes in the face, the holes being drilled so that the stone would hang in the air as near as possible as it would set on the lagging. The beds of the stones on the acute side having such a sharp pitch it was possible that, while the mortar was green, owing to the jar or tremor of trains passing overhead the stones might slip down a little out of place. To avoid this, iron tie rods were used about 12 ft. long, ¼ in. iron 4 in. wide with round bolts through one end 2½ in. long each side, with other ends squared off with iron of same width. There were five of these on each face, holes being drilled for the bolt end in stones 3 and 4, 5 and 6, 7 and 8, etc., and the other end being built up back in the brick work. Coursing and heading spirals were marked over the lagging so that masons could have a line to which to lay brick, the coursing spirals were marked every six courses of brick. The heading spirals are not important in brick work as they could hardly be followed with the eye after centers are removed. Points on a coursing spiral are obtained thus: see Plate No. 4, the angle $E'\ C\ C' = 23° 52'$ by a calculation from triangle $C\ c\ E'$; divide $c E'$ into same number of equal parts as the semi circle on $A\ B$, then $C\ q$ = three of the equal parts of $C\ E'$ and $q\ 7'''' = q\ l - l\ 7''''$; $q\ l = C\ q\ sin\ 23° 52'$, and $l\ 7'''' = vers\ sin\ B\ O\ 7$; then setting the transit on top of lagging on the center line of arch turn the angle 23° 52', lay off the distances $c\ q$ and $q\ 7''''$, three or four such points will determine the spiral. Next take a straight edge 18 ft. long, ½ thick and 8 ft. wide, lay over these points and mark the spirals. The length of the springing line being 80 ft. 2 ins., ring stone 40, or the oblique quoin stone takes up 2 ft. 4¾ ins. of this length, found by multiplying 1 ft. 8 ins. (the chord of a right section equivalent to the thickness of a ring stone, see Plate No. 6, Fig. 3,) by $cot\ \phi$. The length of the quoin stone 1 is 4 ft. 5 ins., this gives a length along the winding bed or coursing joint of 3 ft. 7½ ins., making the length of the skew back along the coursing joint conform with the lengths of the ring stones; of the length on the springing line we have left 73 ft. 4⅛ ins., this is divided into 183 checks of $4\frac{13}{16}$ ins. each, see Plate No. 5, Fig. 2. These checks measure $3\frac{13}{16}$ ins. along a coursing spiral, 2⅝ (thickness of one course of brick) along the heading spiral, and are 30 ins. deep from intrados to extrados, the arch being turned with seven courses of brick. The checks were made of the same dimensions at the extrados as at the intrados, in an arch all stone the top of the check would have to be a little higher at the extrados, but it is unimportant in a brick arch. In setting the ring stones a template, see Plate No. 7, Fig. 6, was used to tell if the ring stones were high or low behind, this result could also be obtained on the face by stretching a string from the center of eccentricity along the face joint. In the template $B\ C\ D$ is cut with a radius of 14 ft., and the edge $A\ B$ is on the radius produced. The straight arm was applied to the bed of the stone and at right angles to the axis of the arch, the curved portion laying over the lagging and being plump.

The centers were placed generally 3 ft. 9 ins. apart

*Reprinted from the *Journal of the Engineering Society of Lehigh University* Vol. III. No. 2.

in the clear, the lagging was 3 ft. thick; full centers extended to the center of the face at each end, and half centers were used to complete the acute corners Where the bents of the alternate trestle were, the centres had to be spaced as the piling would allow. There were 10 plumb or batter posts which went up through the centers, besides numerous braces. The arch was turned over the south end, or where the main trestle was first; this portion was then filled over and the C. W. & B. traffic thrown back from the alternate to the main track; the alternate trestle was then torn out and the remaining portion of the arch completed. There were four varieties of stone used in the work; the impost being made of a very hard blue limestone from Greensburgh, Indiana; the quoin and ring stones of an Oolitic limestone from near Indianapolis; the south face and the wings of a soft sandstone from Lancaster, Ohio, this sandstone hardens with exposture and age: the rest of the arch was built of a freestone from Portsmouth, Ohio, not as good a wearing stone as any of the above. Machine made stock brick were used on the inside course. There were about 164,000 bricks used in the whole arch. The cement used was mostly "Louisville," of the "Horse Shoe" and "Black Diamond" brands, some "Cummins Akron" was also used; in the whole arch about 2,400 barrels. No grouting was done, except in case of ring stones, and face joints; the backing and foundation was made up with concrete. There was a line of 12 in. drain pipe laid on each side from face to face of the arch through the backing to act as conduits in which to carry the telegraph wires.

The following is a statement of the cost of the arch together with that of the other work in connection with it, and consequent to the crossing of the two railroads; by taking items, 1, 2, 3, 4, 7 and 12 we obtain the cost of the arch proper, or without the expense arising from the crossing of the other railroad, to be $46,350.13.

	Quanti's.	Materials Used or Handled.	Price.	Cost.
1	3593	Yards first-class arch masonry	$10.00	$35,930.00
2	13634	Lin. feet piling in foundations	.38	4,952.92
3	23621	Feet B. M. timber	22.00	519.66
4	2254	Pounds iron	.02½	56.35
5	4283	Yards earth excavation	.23	985.09
6	6915	Yards loose rock excavation	.38	2,627.70
7	3398	Yards wet excavation	.90	3,058.20
8	135780	Feet B.M. timber in trestles, etc	19.00	2,579.82
9	1206	Hours labor on trestles, etc	2.50	3,015.00
10		Engine hire (C. W. & B. helper)		4,138.07
11		Cost of siding and C. W. & B. track-gang work		1,143.30
12		Extra cost of stone and stone cutting		1,833.00
				60,839.11

There was no distinction made in the classification of the masonry; foundation, backing and brickwork being all called first-class. As noted, the second item is for piling in foundation, the piling used in the trestles appearing in the item "timber in trestles, etc." Timber in foundation refers to 10 ft. × 12 ins. caps and 4 ft. plank covering them only. The iron in foundation is the weight of drift bolts and spikes used in spiking down the caps and planking. The earth, loose rock and wet excavation includes cutting through the C., W. & B. embankment, sinking the foundation pits and borrowed materials to make the C., W. & B. bank after arch was finished. The item "timber in trestles, etc.," also includes the piles in the same and sheeting plank and bracing for the foundation pits.

The "labor on trestles, etc.," includes framing and erecting trestles, driving piles for the same, maintaining and altering them during the progress of construction, and tearing them out when the arch was finished, also labor in sheeting and bracing foundations. In explanation of the item "engine hire," it must be recalled that the point of crossing of the two railroads was at a marked depression in grades on the C., W. & B., so that in case of heavy freight trains it was necessary to have an extra engine to help such trains up the heavy grades. All trains slowed up going over trestles, nominally to 8 or 10 miles an hour, though some ran at least 25 miles an hour. In all an average of 52 trains per day crossed the trestle. The helper being an additional expense to the C., W. & B., our company had to meet it. A siding was put in for our use in connection with the building of the arch, and their track gang had several days' work in the line of shifting their tracks and the constant expense of a watchman.

The oolitic stone cost considerably more than the other varieties of stone used, and the cutting on the impost, quoin and ring stones was undoubtedly in excess of what is ordinarily considered first-class masonry. The engineer of construction very properly made a suitable allowance to the contractor for such extra work. The centers were also extra heavy to help carry track, if necessary, and some allowance was made the contractor for this also.

J. FOSTER CROWELL, M. Am. Soc. C. E., was engineer of construction from whose plans entirely the arch was built. I was indebted to him for many practical suggestions and solutions of knotty points which presented themselves during the construction. Mr. S. CASPARIS was the contractor and THOMAS OWENS the foreman mason. The shifting stock was the idea of my rodman, E. T. MCCONNELL, and to his interested application and close inspection of the work is due much towards its successful completion. Mr. MCCONNELL also assisted me in preparing the drawings and ring stone models for this paper.

The Proper Relation to Each Other of the Sections of Railway Wheels and Rails.

[Preliminary Report of the Committee on this subject to the American Society of Civil Engineers.]

Your Committee to whom was referred the question raised in the subjoined resolution* have been greatly impeded by pressure of other duties from holding such meetings and giving the matter such study as would warrant the submission of a final report in the first instance, and in view of the importance of the question raised it seems undesirable to do so in any case until the information which they have collected and the conclusions which seem to be indicated have been submitted for discussion, with the probable result of bringing out further information bearing on the matter. They therefore submit the following preliminary or progress report, postponing to a later date the preparation of a final report giving conclusions.

Your Committee understand the question submitted to them to be substantially this: Is it preferable that the sections of rail and wheel should stand to each other in relation shown in Fig. 1, in which the fillet of the flange is to a larger radius than the corner of the rail, so that the rail and wheel can only come in contact on the top

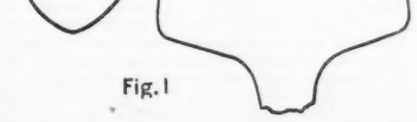


Fig. 1

or at a single point on the corner; or is it desirable that the radii of the flange-fillet and rail corner should be the same, as also the radii of the inside half of the rail top and the corresponding part of the wheel tread, so that the two shall be normally in contact with each other over the entire distance from *A* to *B*, both on curves and tangents, as shown in Fig. 2, whenever the flange approximates to the wheel at all.

THE CLAIMS MADE ON EACH SIDE.

Summarizing these as impartially as may be, it is claimed in behalf of the form shown in Fig. 1.

First.—That it is the customary and most common form, and has the burden of proof in its favor, being now almost universal.

Second.—That it is the most practically convenient and attainable form, since it does not require the radii of either fillet or rail corner to be always the same, whereas the conditions of Fig. 2 are only attainable by universal agreement to make both rails and wheels always of the same radii.

Third.—That it is the form of least wear, since on tangents and on the inside rail of curves there is a purely rolling contact on top, and on curves an almost purely rolling contact on the corner of the rail, whereas in Fig. 2 there is rubbing flange friction at *A* both on curves and tangents, which produces an excessive wear from the beginning of the life of the rail, such as can only exist in Fig. 1 on old outside rails of curves after they have been much flange worn, as in Fig. 2 below.

Fourth.—That it is the safer form, in that the flange will not so readily mount the rail.

Fifth.—That the form of the rail is not as a matter of fact a cause for sharp flanges to any appreciable extent.

Sixth.—That even if it were, the loss by sharp flanges, is a small one, if indeed there be any.

On behalf of the form shown in Fig. 2 it is claimed:

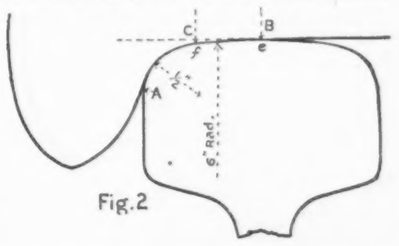


Fig. 2

First.—That the form shown in Fig. 1 offers too little bearing surface, which it is desirable to increase.

Second.—That the form shown in Fig. 1 is a cause for sharp flanges, which is removed by making the fillet and rail corner exactly fit each other, as in Fig. 2.

Third.—That the loss from sharp flanges is so serious as to demand a remedy.

Fourth.—That no extra wear or extra danger of derailment will result from the form shown in Fig. 2 to outweigh its alleged advantages.

Your Committee have collected quite a body of statistical information relating to the question submitted; much more, they apprehend, than has ever been collected in relation to the question before, including some of a quite novel character specially compiled for them, which sheds a great deal of light on it. This is especially true of the records of the Pennsylvania Railroad, which from the many years (ten) and vast number of wheels which they cover, are of quite unequalled value for the purpose in view. Their completeness has also enabled your Committee to trace to its source an error of great magnitude and importance in regard to the proportion of sharp flanges on the Pennsylvania and other roads, which appears to have had a good deal of influence in creating the antagonism of views which led to the appointment of your Committee.

They have subdivided their investigation, and the following report, under the following heads: First, Historical; second, Statistical; third, Theoretical; fourth (to be given in a final report), Summary of conclusions.

HISTORY OF ACTION ON THIS QUESTION.

Your Committee have not been able to discover that the doctrine that the rail and fillet radius should correspond has ever been advanced in any authoritative way until within the past few years. The first formal action to that effect was a brief report by a Committee of the Master Car Builders' Association in 1883, who stated that they were "strongly of the opinion that by far the greatest cause of sharp flanges" was the sharp corners of the rails, and recommended that the rail be rounded off to a ⅝-inch radius, so as to "exactly fit the flange." The conclusions of a previous Committee, that sharp flanges were due to special defects of truck wheels, bad gauge of wheels, trucks not square, wheels not of the same diameter, overloading of side bearings, unequal loading of car, imperfect chilling, etc., were enumerated as secondary causes.

No action beyond receiving it was had on this report, but immediately thereafter Mr. M. N. FORNEY, M. Am. Soc. C. E., Secretary of the Association, took up the matter in an elaborate paper presented at the 1884 Convention, information for which was gathered by circular in the name of the Association and which was (in effect) endorsed and accepting by the above-mentioned Committee as giving their views and relieving them of the necessity of making a report.

This paper has been very widely circulated. Officers of Maintenance of Way were formally invited to attend and take part in its discussion, and your Committee have reason to believe that this paper and resulting action thereon has largely given rise to the unfounded impression, which is nevertheless widespread, that the Master Car Builders' Association, as a body, has acted on this matter, and that the paper was a *quasi* official protest on their part against the bad form of rails This is not the case,

*The Committee is acting under the following resolution:

"*Whereas*, The relation which the form of the head of a rail should bear to the section of a car wheel tread and flange has recently been in dispute, it being asserted on the one hand, that they should have as long a line of contact as possible and, on the other hand, that such long contact would be dangerous and injurious; and,

Whereas, The question raised by this diversity of views is of direct importance to the many members of this Society, as well as to public interest, and hence is one which this Society may appropriately consider through Committee; therefore be it

Resolved, That a Committee of five members of this Society be appointed by the President to consider and report to the Society on the proper relation to each other of the sections of rails and wheels; to what extent and at what points it is expedient that their sections should be such as to bring them normally in contact, and to what extent and at what points it is not expedient that they should be so in contact, and that the Committee be instructed to seek information from all those who are known to have given the subject attention."

At about the date of this paper the Pennsylvania Railroad changed their standard to a round cornered rail, and one or two other roads followed suit. Several years previously, in 1883, the Lehigh Valley Railroad adopted what is now their standard section, and generally known as the Sayre rail designed by Mr. ROBERT H. SAYRE, C. E. In regard to his reasons therefor, he states in a letter to a member of your Committee:

"The sharp cornered rail attacks the wheel in its most valuable point, and while the rail is being worn down to conform to the normal shape of the wheel, you are ruining the wheel, which costs more per ton than the rail, by cutting through the chill and wearing the flange straight. Carefully kept records on the Pennsylvania Railroad for a period of five years, while they used a sharp cornered rail section, showed that 40 per cent of their wheels removed were worn through the chill in throat or had straight flanges. I had records kept on the Lehigh Valley Railroad for three years, and found the loss from the same cause was less than 4 per cent."

Passing for the present the questions raised in the first part of this quotation,* the substance of the closing sentence has been repeatedly alleged by various persons in the discussions of the Master Car Builders Association and elsewhere, and your Committee think there is reason to believe that this one supposed contrast in statistics has had very great influence with many persons and on much of the action had, in favor of round-cornered rails to fit the flange. They have therefore investigated its truth with all possible care, and find that it is founded on an entire misapprehension, the error being that the per cent. of worn out rails only on the Pennsylvania is compared with the per cent. of all wheels on the Lehigh Valley. The correct figures, which appear in this report, and which have never been in print or even collected in manuscript before, indicate that the Lehigh Valley percentage is not now and has never been lower than on the Pennsylvania, and (apparently) that on both roads the percentage of sharp flanges has increased very materially since the adoption of the round-cornered sections.

The paper by Mr. M. N. FORNEY, before referred to, while quite elaborate in other ways, bases the conclusion that the radii of rail and fillet should correspond on the following argument only:

"As the maximum weight carried by car-wheels is now from 5,000 to 8,000 pounds, the bearing surface must be subjected to pressures of from 40,000 to 64,000 lbs. per sq. in. It is therefore not surprising that they are rapidly worn away, as there is no principle in mechanics more firmly established or more certain than that the wear of surfaces in frictional or rolling contact is in an inverse proportion to their area. Therefore, if we should increase the area of the surfaces of the wheel and the rail which are in contact, the capacity of both for resisting wear will be increased. To do this, their forms must be made to correspond to each other. In other words, the treads and flanges of wheels should be made of the same shape as the heads of the rails."

Postponing for the present further discussion of this argument than to say, first, that it neglects the question of whether the recommended course will not substitute mixed rolling and sliding friction for purely rolling contact, and so materially change the nature of the problem, and second, whether the pressures named are really injurious for the bearing surfaces of wheels and spheres, because they are undoubtedly so far the bearing surface of prisms, which had no greater section anywhere than their bearing surface, your Committee present it in full, as the only scientific argument which has ever been made public, to their knowledge, in favor of a doctrine which has obtained such wide currency as to be acted on practically by several of our leading lines. Your Committee now proceed to summarize the statistical facts which they have collected in regard to the wear of rails and wheels as affected by their forms.

*It may perhaps be well that your Committee should here note, however, that the first sentence above, in respect to "the rail being worn down to conform to the normal shape of the wheel" does not seem to conform to the facts of experience, as evidenced by the accompanying sections of worn rails (Figs. 32 and 33), reproduced from Mr. Forney's paper, before referred to. Fig. 32 is from a rail laid on tangent on the Philadelphia and Reading Railroad in 1875, and taken up in 1882, after about 105,000,000 tons had passed over it. Fig. 33

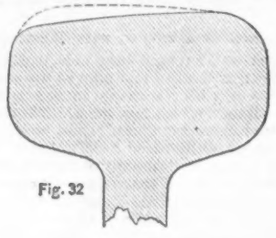


Fig. 32

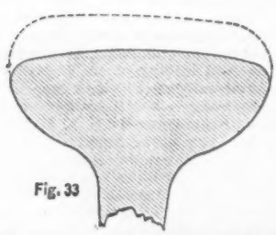


Fig. 33

Worn Rails, Phila. & Reading R. R. Showing Tendency of Round-Cornered Rails to Wear Sharper.

is from a similar rail laid in 1867, after 176,000,000 tons had passed over it. In both cases it will be seen that the original round corner has worn down to a very sharp corner. It is obvious that if it be in fact the case that the rail corner tends to cause sharp flanges by wearing away the fillet to a smaller radius, the tendency of the flange fillet should be to wear off the rail corner to a larger radius; yet the two rails shown, made with the original corner radius nearly as large as the flange fillets, for the express purpose of avoiding wear in the latter, have worn down to about as small corner radii as are ever used in new rail sections.

STATISTICAL RECORDS.—THE PERCENTAGE OF SHARP FLANGED WHEELS.

On this question, as also on the far more directly important question of comparative mileage life, your Committee have collected the information, which appears in the accompanying tables and subjoined appendices, being as much as seemed at all necessary for the purpose.

The relative percentage of sharp flanged wheels needs to be considered in connection with statistics of comparative mileage, to be shortly presented, and it is also to be remembered and allowed for that there is much irregularity in classification. This is especially conspicuous in steel-tired wheels. Thus, the Boston and Albany and Lake Shore and Michigan Southern report no sharp flanges whatever among steel-tired wheels. On the other hand, the Chicago, Burlington and Quincy reports 47 to 50 per cent., although the mileage of these sharp flanged-wheels is higher than any other.

The total per cent. of sharp flanges reported, out of wheels removed for all causes, may be said to range from 2 to 12 per cent. in passenger service, and from 3 to 20 per cent. in freight and engine service. The following are a few definite figures: [Omitted as of no great interest. ED.]

Many of the irregularities are due to peculiarities of classification, but further precision or a more elaborate summary appears unnecessary in view of the following facts as to relative mileage life.

THE RELATIVE MILEAGE LIFE OF SHARP-FLANGED WHEELS.

Your Committee find it clearly indicated from all the data which they have collected, and in part append to this report, that the average mileage life of wheels removed for sharp flanges is very decidedly above the average life of all wheels, and is even, with one partial exception, the highest among the various causes for removal of wheels worn out by legitimate wear only. This is assuming the quality of the wheels to be of fair to good quality. As the quality of the wheel falls below this average quality (which included, perhaps, three-quarters or seven-eights of all the cast wheels in the United States), the statistics to be shortly presented will show that the percentage of sharp flanges very rapidly increases, and it may be (although your Committee have no evidence of that fact) that the relative mileage life of sharp flange wheels is less, since bad wheels are particularly apt to be soft in the fillet chill.*

The most valuable and decisive evidence as to relative mileage life are the returns of the Pennsylvania Railroad, shown in Table No. 3, and others, since they cover a long period of time (1878-87, ten years) and a large number of wheels, during which time a rigid, minute and uniform system of classification has obtained. The main part of this record covers only wheels which have failed by wear from legitimate causes, excluding all "slid flat" wheels (which covers from 50 to 60 per cent. of all removals under the rigid Pennsylvania inspection), as also all wheels removed for any cause fit for refitting or freight (20 to 25 per cent. of all removals), and also wheels removed as cracked or broken (less than 1 per cent. of the total). The average mileage of these excluded wheels is, of course, vastly lower than those which are included, which fail from wear.

Those which fail by legitimate wear only, are subclassified under these eight heads: 1, "Shelled out"; 2, "Comby"; 3, "Seams"; and 4, "Worn flat"; terms which in a measure explain themselves, and imply more or less imperfection in the wheel; 5, "Worn flange" under which head are included all ordinarily classed as sharp flanged; 6, "Hollow at flange", wheels worn in tread close to the flange, but not so as to cut into the flange abnormally; 7, "Hollow from flange", which means wheels worn deepest in the tread away from the flange, and presumably mated with wheels which run to flange. To these is added a very small class of miscellaneous.

The comparative service which wheels removed for each of these defects have rendered on the Pennsylvania Railroad for the past ten years is given in detail in the Appendix, and summarized in the following Table No. 2, the significance and importance of which, as respects the question now under discussion, your Committee think it would be difficult to exaggerate. They are not aware that any similar statistics have ever been computed or made public before.

TABLE 2.

RELATIVE MILEAGE LIFE of Worn out Wheels only (excluding Slid-Flat and Cracked and Broken Wheels) on the Pennsylvania Railroad. Average of Nine years, 1878-86, as shown in detail in Table No. 3. (1887 added separately for comparison.)

CAUSES OF REMOVAL. (In inverse order of mileage.)	Baggage, Express & Postal.		Passenger, Combin'tion & Emigrant.	
	1878-'86	1887	1878 '86	1887
1. Comby	62,120	70,369	53,840	60,924
2. Seams	64,880	88,974	52,150	62,916
3. Shelled out	71,290	75,483	54,980	58,257
4. Worn (not slid) flat	73,110	78,368	61,310	56,510
5. Hollow in tread at flange	75,550	59,866	63,810	37,516
6. Worn (sharp) flange	78,720	75,390	66,790	60,919
7. Hollow in tread from flange.	81,810	70,866	67,450	50,504
Average of the two classes of wheels which fail from wear of tread only and not of flange (Nos. 5 and 7)	78,680	65,366	65,630	44,010
Against sharp flange wheels	78,720	75,390	66,790	60,919
Average of causes 1 to 4	67,850	78,298	55,652	59,647

Note.—Table 3, showing in detail for each year the average mileage of wheels removed as worn out, for each leading cause of removal on the Pennsylvania Railroad, 1878-86, inclusive (wheels removed as cracked, broken or flat from sliding excluded) is omitted as sufficiently indicated by Table 2.

This table shows only the nearest even ten miles, because the average was so computed to save space and time.

It will be seen that the average mileage of wheels with "worn flange" is very markedly above the average of other wheels which fail from wear, and is even appreciably higher than the average of the two select classes of choice wheels which fail from "old age" only, *i. e.*, those which show no other sign of defect up to their date of removal than that the tread is too deeply worn (although evenly worn all around) to permit of longer service. This class of wheels constitute only a very small percentage of the total drawn from service (2 1-2 to 3 per cent.), just as old age constitutes a very rare cause of death among human beings, and for precisely the same reasons. It requires an entire absence of specific defects of structure.

An alleged disease among human beings which showed a somewhat higher average age at death than the average of deaths from old age, would not ordinarily be regarded as a very serious matter, nor would there be any great anxiety to decrease the number of those who died by it; and your Committee cannot but regard it as a highly significant and important fact that in this most complete record available (which agrees in substance with all the others subjoined), the wheels which show the very highest mileage, practically, are those which have been drawn at last because they were suffering from a disease which it has been supposed was so important to cure, "worn flange."

This is especially notable, if we consider further that (1) there is much less metal to wear away to make a wheel sharp-flanged than to make it hollow-tread; (2) that a hollow-tread wheel has a much greater bearing surface than one which is running to flange, which should reduce the rate of abrasion if the greater bearing surface is a gain, and (3) and chiefly, that inspection will naturally be much sharper and removal quicker with sharp-flanged than with worn tread wheels, the latter being in no sense a dangerous defect.

The following Table 4, shows the percentage of the various causes of removal among worn out wheels only, from which it will be seen that the worn flanges are now 37 per cent. of such wheels, and the worn treads, including "worn flat", 13 per cent. The steady increase in number of sharp flanges is notable.

TABLE No. 4.

PERCENTAGE OF VARIOUS DEFECTS in wheels removed as worn out (excluding "slid flat" and "cracked and broken" wheels) from Passenger, Combination, Emigrant, Baggage, Express and Postal Cars, Pennsylvania Railroad.

FOR DETAILS, SEE TABLE A, APPENDIX.

Causes of Removal (Worn out wheels only)	Per Cent. of Each			Av.m'le'ge Passenger, Combination and Emigrant. 1878-86
	1878-83 6 years	1884-86 3 years	1887 1 year	
Shelled out	29.83	17.96	13.15	54 980
Comby	7.48	33.88	35.09	53 840
Seams	5.28	1.92	0.89	52 150
Worn flat	10.36	3.90	2.26	61 310
Worn flange	20.63	29.87	35.72	66 790
Hollow in tread at flange	4.84	2.73	1.87	63 810
Hollow from flange	11.90	9.08	8.42	67 450
Miscellaneous	3.68	0.66	0.60	.....
Total (worn out only)	100.00	100.00	100.00	.....

Note.—The round cornered rail (⅝-in. radius) was made standard on the Pennsylvania in 1884 and in 1884 a change of fillet radius was made from ¾ to ⅝-in.

Of the wheels excluded from this table, "slid flat" wheels constituted (probably under a very rigorous classification) from 50 to 60 per cent. of the total removals; "cracked and broken," only a very small per cent.; considerably under one per cent. Wheels fit for freight service are also excluded, and constitute 20 to 25 per cent. of the total removals.

The more important further evidence as to relative mileage life collected by your Committee, may be summarized as follows: [Some matter of the same general nature as above as to the Pennsylvania Co., and Lake Shore & Mich. Southern Ry. omitted. ED.]

As further evidence, in the Master Car Builders' Report for 1881 a list of 42 single wheels is given for another purpose, 8 of which had sharp flanges, but the mileage of the sharp flanged wheels was considerably higher than the average of those removed for any other cause, even the general one, "worn out."

Your Committee know of no evidence of a contrary character to the above to indicate that flange-cut wheels ever show a low mileage. On the contrary, it appears to be a fact well known to those who have given attention to the matter (although it does not seem always to have been duly considered), that sharp-flanged wheels make a very high mileage.

Mr. T. N. ELY, M. Am. Soc. C. E., General Superintendent of Motive Power of the Pennsylvania Railroad, says in a letter subjoined:

"The average mileage of wheels removed for all causes shows that there is no great difference between those removed for worn tread (or 'hollow from flange" and those removed on account of 'worn flange.'"

"In the majority of cases, however, these worn 'hollow from flange' give the higher mileage, although in some years the reverse was the case."

"In all cases, however, the average mileage of wheels, with these two defects, was much higher than for the other causes."

These notes appear to be based merely on comparison of the 9 years separately. When averaged together, as Tables Nos. 2, 3 and 4 above, they give the still clearer and more emphatic evidence shown.

We abstract in Table No. 5 the percentages for each year of sharp flanged wheels (in the worn-out wheels only) on the Pennsylvania Railroad, which shows still more clearly that the percentage of sharp flanged wheels has been increasing since the round-cornered standard rail-sections 1884 and 1885 were adopted, although that section was adopted with the express purpose of decreasing flange wear.

In view of all the preceding, your Committee see no escape from the conclusion that in spite of the less bearing surface, the less material to wear away to condemn, and the closer inspection, wheels which are wearing sharp at flange make, if anything, a larger mileage than any other class of wheels, and certainly show no appreciably less mileage under normal conditions. This rather surprising conclusion, which was unexpected to every member of your Committee, necessarily implies that the rate of abrasion of metal from wheels which are wearing sharp at flange must be materially less in pounds per thousand miles than in wheels which are wearing hollow in tread, because there is a smaller amount of metal to wear away to have the wheels unserviceable. We shall shortly see reasons why this should be so, both from theory and from observations on rail-wear, but before doing so it will be desirable to summarize the evidence of statistics as to the causes of sharp flanges.

(TO BE CONTINUED).

TABLE No. 5.

PERCENTAGES OF WORN OUT WHEELS only (Excluding Cracked and Broken and Slid Flat Wheels) Removed on the Pennsylvania Railroad, 1878 to 1887, for Worn or Hollow Flanges. [Altoona Cast Wheels, of substantially same composition and quality throughout the period covered.]

Class of Service.	1878	1879	1880	1881	1882	1883	Average
Baggage, Express and Postal	29.20	24.14	35.19	30.98	16.28	17.23	25.50
Passenger, Combined and Emigrant	28.57	25.45	27.84	34.03	27.95	22.08	27.75

Class of Service	1884	1885	1886	1887	Average
Baggage, Express and Postal	23.74	31.67	39.65	39.76	23.70
Passenger, Combined and Emigrant	22.32	28.05	83.79	33.69	39.46

The Main St. Arch of Springfield, Mass.

As we have had already considerable to say upon the subject of the proposed arch for Main Street, Springfield, Mass., we take pleasure in reproducing the latest design, brought out mainly through the interest shown in the public welfare and adornment of Springfield by the *Republican* of that city.

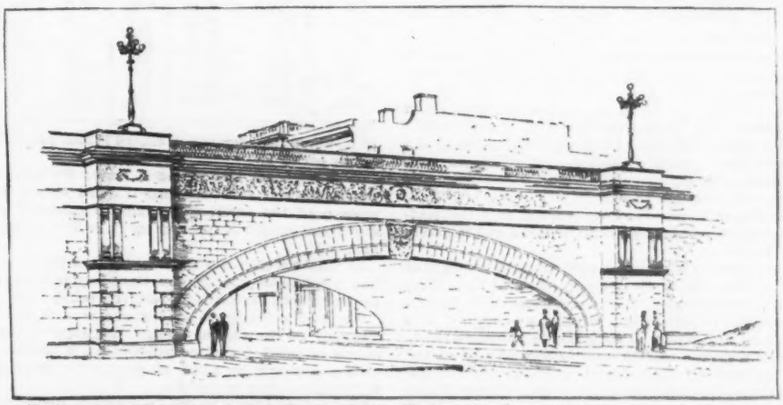
The excellent design here submitted is that of GEO. C. GARDNER, an architect well known for his works and his racy writing on architectural subjects. In criticizing this plan it should be remembered that the original decree authorizing this arch handicapped the designer by several arbitrary conditions from which there could be no deviation. The bridge was to have a certain height at the crown and track-level, and was to have a parapet 12 ft. high surmounting the arch. This latter condition accounts for the apparently useless depth of the structure just over the crown, a fact which interferes with its grace and lightness to some extent.

The objection made to the plans of Messrs. HERSCHEL and TOWER, shown in our issue of July 28, was that they were too severely massive for the site, and the further point is raised that of all the previous plans submitted each shows an unfinished arch, from an artistic point of view; inasmuch as they spring from the ground and leave the imagination to picture the remainder of the sweep that may be buried beneath the surface. While this latter objection will hardly apply to the flat arch design of Mr. HERSCHEL, the treatment here shown is certainly more pleasing in this respect.

Mr. GARDNER, in describing this arch, says that it is a combination of the circle and ellipse, a combination pleasing in form and best adapted to the dimensions and conditions of use. The design is a very simple Renaissance, and while this does not conform with the style of the new depot, which is as nearly Romanesque as anything—or more truly, Richardsonesque, a Romanesque bridge with an elliptical arch would be "in about as good taste as a mixture of Charlotte Russe and curried chicken." But the style adopted, admitting as it does of light details and forms, does conform with its nearest neighbor, the Boston & Albany offices. Three varieties of stone are used to further lighten the structure in appearance by their contrasting colors.

Commencing with the top of the bridge, the parapet is crowded with a balustrade of turned Ohio stone balusters, placed closely together. This would give a lightness which it is impossible to attain with a solid top, and at the same time would avoid a broken line, which with the background of buildings that it would always have, would be very disagreeable. The decorated frieze is of Ohio stone, this band being the main decorative feature in the structure. The center of this belt, directly over the key-stone, would be an appropriate place for a medallion portrait of the founder of the road. The rest of the trimmings would be of brown-stone, and the main body, the portions requiring strength, both real and apparent, of Braggville granite. The dimensions are very nearly those of the first design. The clear height under the bridge at the center of the arch is 14 ft. From the street to the top of the parapet 30 ft. and the tracks are 11½ ft. below the top of the parapet. Allowing 50 ft. for the street, and 8½ ft. for each sidewalk, there is a clear height of 6 ft. 8 ins. at the lowest point over the walks. With this same allowance, there would be about 3 ft. at either side between the walks and the spring of the arch. The radius of the segmental portion is 80 ft.

It might be said that in Mr. GARDNER'S design the depth of the arch voussoirs is too great. While this depth is broken by the intermediate moulding, 6 ft., or nearly so, seems to be more than even this comparatively flat arch of 66 ft. span requires, and the effect is just a little too much of that "massive" appearance objected to in other structures. We can see a reason for this, however, in the attempt to reduce as much as possible the depth above the crown required by the conditions of the "decree", which did not leave the architect free to design as he thought best in all points.



Design for Main St. Arch, Springfield, Mass.,; by GEO. C. GARDNER, *Architect.*

Portland Cement Concrete.

Mr. DYCKERHOFF, a well known German authority on Portland cement, has contributed a somewhat remarkable article on this subject to a recent number of the *Deutsche Bauzeitung*. He considers that a comparatively small proportion of cement thoroughly incorporated with the sand and broken stone of the concrete is much more advantageous than a much larger quantity less carefully mixed. For foundations he recommends the use of one part of cement to from 6 to 8 parts of sand or gravel, or to from 8 to 10 parts of broken stone. In those cases in which the structure is subjected to heavy shearing forces, these proportions should be somewhat reduced, one part of cement from 5 to 6 parts of sand being then more suitable.

In the case of very important work Mr. DYCKERHOFF recommends the carrying out of experiments to settle the proper proportion of cement to sand, employing in the experiments samples of the same sand that will actually be used in the work, as sands differ so much in constitution that often a comparatively dull and bad-looking sand will give much better results when tested in this way than sands of much brighter and better appearance. This of course does not apply to sands clearly clayey. In making the concrete the cement should not be measured, but weighed, as the weight contained in a measure varies considerably. In his own practice he uses as a unit a sack of cement, which is of invariable weight. The sand and cement are mixed dry in a wooden trough, and turned over 3 or 4 times with a spade before the water is added, after which it is again thoroughly worked till it forms a homogeneous and slightly damp mass. The broken stone, gravel, etc., which has been carefully washed and is still damp, is then added and the whole thoroughly reworked, so as to completely cover each fragment of stone with the cement, a point of the greatest importance.

Workmen are deputed to prevent any of this stone working to the top during transit from the mixing table to the site of the works, and equal care is taken in depositing it in the trenches, careful and experienced men alone being employed, as without this precaution the success of the work cannot be assured To finish off the work Mr. DYCKERHOFF makes use of cement mortar consisting of 1 part of cement to 2½ parts of sharp sand, to which is added if the sand is course, 1-10 part of fat lime, which makes the mortar spread more easily. Before applying the mortar to the work the latter is carefully washed and levelled, after which the mortar is applied in 3 or 4 successive layers.

The Plan and Location of the Quaker Bridge Dam.

The following is the full corrected text (some noted abbreviations excepted) of the Report of the Board of Experts on plans for the Quaker Bridge dam, containing some changes from and additions to report as originally submitted.

After briefly stating the circumstances of their appointment, report continues:

The proposed location of the Quaker Bridge dam is at a point on the Croton river, about two miles above its mouth, where the steep sides of the valley approach to form a ravine. This ravine is about 1,300 ft. wide at an elevation of 230 ft. above tide level, 300 ft. wide at the level of the river bed, 35 ft. above tide, and has a rock bottom 87 ft. below the stream level, or 52 ft. below tide level in the Hudson river

It is proposed to close the ravine with a masonry dam which will impound the waters of the stream and raise the water-level to a height of 200 ft. above mean high tide: The greatest height of the dam from foundation level to the top of road parapet will be, therefore, from 265 to 270 ft., depending upon the character of the surface of the rock at the deepest point.

It will be about 100 ft. higher than any dam yet built.

It is to impound upwards of 5,000,000,000 cu. ft. of water in an artificial lake 16 miles long and 165 ft. deep at its lower end. The water-shed tributary to it has an area of 361 sq. miles, and contains a number of storage basins with an aggregate capacity of 1,200,000,000 cu. ft., averaging about 7 miles distant from the Quaker Bridge Lake and 300 ft. above its level. A new dam is now building which will increase this capacity to upwards of 1,800,000,000 cu. ft.

The greatest recorded flood of the river, measured at Croton dam, is 1,070,000,000 lbs. cu. ft. in 24 hours.

(After stating that consideration was restricted to masonry dams, the forces acting on the structure are classed under four general heads:

First—The quiescent and ever-acting forces, such as the weight of the masonry and the pressure produced by the impounded water.

Second—Forces produced by the expansion of ice in place or by floating masses.

Third—Forces produced by waves of translation, the possible cause of such waves being the giving way of a dam above or an extensive land slide.

Fourth—Earthquake shocks.

1.—*Quiescent Forces.*—It was determined that the specific gravity of the masonry should be taken at 2.34, giving 146.25 lbs. per cu. ft.

KRANZ assumes a specific gravity of 2.3 or a weight of 143.75 lbs. per cu. ft for masonry built of hard stone (granite or limestone). The experiments of M. BOVIER upon granite rubble led him to adopt a weight of 117.3 lbs. per cu. ft. While building Boyd's Corners dam o the Croton river, a careful account was kept of all the materials entering into its construction, from which account the specific gravities of the various classes of masonry were computed. These varied from 2.13 to 2.71,and the specific gravity of the whole mass was found to be 2.34, and we have thought it best to adopt the same specific gravity for the Quaker Bridge dam.

The aggregate length of the spill-ways will be about 1,300 ft. A depth of about 2.25 ft on the crest would pass the largest recorded flood in the valley, and it will be only on rare occasions that the water can reach the elevation of 232 ft. above the tide. This elevation for the water surface, as producing what may be termed the maximum quiescent stresses, has been adopted in computing the pressure which the masonry throughout the body of the dam must resist.

The waste-way, or channel for carrying off the surplus waters from the surface of the reservoir, will be constructed in rock cuts and over subsidiary dams so situated that the overflowing water will not touch the main dam.

2. *Ice.*—In our search for information upon the expansive force of ice in place, caused by increase of temperature, we found little of value recorded; but we obtained valuable, though somewhat conflicting information by correspondence and personal interviews, which information, supplemented by experimental data concerning its strength, elasticity and rate of expansion under a rising thermometer, has led us to the opinion that the dam should be proportioned to resist a thrust at the highest ice line of about 43,000 lbs. per lin. ft.

"More positive information was available regarding the force exerted by ice floes. Under certain unfavorable conditions, where ice jams form in a quick running current, it appears to be almost irresistible by direct opposition. But as, in the case of the Quaker Bridge dam, the water current, when there is one, will tend to divert the floes away from it, and direct impact can be produced only by sheets of ice driven by the wind, we have concluded that, if the dam be proportioned to resist the pressure above mentioned, it will be of ample strength to withstand the attack of floating masses.

3. *Waves of Translation.*—To secure the dam from injury by waves of translation, its upper portion where the effect of such waves would be greatest, has been so designed as to give a co-efficient of at least 2 against overturning, when the water-level may be at an elevation of 214 ft. above tide, or at the top of the parapet.

4. *Earthquakes.*—Earthquake shocks may vary from a slight tremor to an immeasureable force. The dam, if proportioned to resist the forces before considered, will have ample stability to withstand all but shocks of the severest nature. Probably of all the considerable structures in the region affected by such an earthquake it would be the last to succumb.

II.—*The Profile or Cross-section of the Dam.*—To resist these forces, or at least those of them which may be considered measurable, we have agreed,

(*a*) That the co-efficient against overturning should, at all points, be not less than 2;

(*b*) That the ratio of the weight of the masonry above any horizontal plane or joint, to the maximum force tending to cause sliding or shearing along the plane, should not be less than 3 to 2;

(*c*) That the maximum quiescent stress on the down-stream end of the joints at the elevation of the river-bed, 35 ft. above tide, should not exceed 10 tons per sq. ft. (= 139 lbs. per sq. in);

(*d*) That below that elevation, where the strength of the masonry to resist crushing is aided by the lateral pressure of the earth, the maximum quiescent stress should not exceed 14 tons per sq. ft. (=194.5 lbs. per sq. in.); and

(*e*) That the pressures upon the joints of the up-stream face may be somewhat greater, since they will be permanently reduced as soon as the reservoir begins to fill.

We agree in judging it prudent that in so important a structure as the Quaker Bridge dam these conditions should be fulfilled, and we believe that, if fulfilled, the cross-section will be amply strong for the functions it will be called upon to perform.

The profile designed by the Engineers of the Aqueduct Commissioners and submitted to us by the Commissioners, does not meet the requirements which we think should be met, for complete safety. We were, therefore, under our instructions as we understood them, called upon to prepare a profile which we could recommend for adoption. We have prepared such a profile and herewith present it under the title, Profile N.

Comparing this profile with that of the Aqueduct Engineers, which we have designated Profile Y, the chief point of difference is in the greater thickness of N in the upper portion of the dam. This increase of thickness appears necessary to resist the shock of ice and excessive freshets. The amount of masonry above the plane 100 ft. below the level of the flow line of the reservoir, will be about 40,000 cu. yds. greater by Profile N, than by Profile Y.

The appended diagrams show graphically for each of the profiles Y and N, the pressures on the down-stream toe of the masonry, and the factors of safety at different elevations and under the three conditions we have assumed.

The greater stability and uniformity in increase of pressures from top to base of the dam, attained by using Profile N, are evident from inspection of the diagrams and the following table:

Two other profiles were also referred to us by the Aqueduct Commissioners, one of which designated as X, was designed by the Engineers of the Department of Public Works, and the other, designated as Z, had been presented to the Commissioners by Mr. A. MARICHAL.

Comparing these with Profile N, it is evident from inspection of the diagrams and tables appended hereto that the pressure at the down-stream toe in the lower portion, and the factors of safety in the upper portion are so different from those which we are agreed should be adhered to, that further discussion of them seems needless.

It should be said, however, of these profiles, as well as of Y, that while the down-stream toe pressures are greater than in any existing dam, and much greater than is recommended as a maximum limit by writers on the subject of high masonry dams, yet in our opinion they possess, if built on a straight line, sufficient strength to resist, for a long time at least, what we have termed the maximum quiescent pressures, but we agree in thinkiag that they would not afford that margin of safety which is required in a high dam, especially one of vital importance to a great population, against the extraordinary forces that in the course of time may be brought to bear upon it.

As possessing some interest for purposes of comparison of profiles, we also present in the appendix, four other profiles designated A. B. C. and I.. [The brief discussion of these plans, which are in the nature of preliminary studies, we omit.—ED.].

We desire to express our obligations to the engineers of the Aqueduct Commissioners for the information furnished us and the computations made at our request, and we would especially acknowledge the services of Mr. F. W. FROST, C. E., in the thorough analysis of the various profiles we have had under consideration, involving a great amount of work which has been most carefully and intelligently done by him.

COMPARATIVE STATEMENT OF DOWN-STREAM TOE PRESSURES, AND FACTORS OF SAFETY AGAINST OVER-TURNING, IN THE PROFILES Y AND N AT DIFFERENT ELEVATIONS UNDER THE ASSUMED CONDITIONS.

Y (Commission plan) on a straight line in plan.
N (Recommended plan) on a curve of 1,300 ft. radius.

Elevat's	Water + 202. Pressures lbs. per sq. in.		Water + 202. Factor of Safety.		Water + 214. Pressures lbs. per sq. in.		Water + 214. Factors of Safety.		Ice on Full Reservoir. Pressures, lbs. per sq. in.		Ice on Full Reservoir. Factors of Safety.	
	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N
192	.....	22.60	....	89.50	.....	25.23	....	9.83	.....	27.54	.....	20.42
184	.....	28.66	....	26.30	.....	36.34	....	6.31	.....	45.18	.....	3.91
173	47.8	37.60	5.38	11.04	91.1	52.94	1.92	4.18	130.4	63.95	1.03	2.89
162	.....	48.40	....	6.63	.....	71.22	....	3.17	.....	79.75	.....	2.61
151	70.4	59.45	2.80	4.81	144.4	88.76	1.48	2.64	319.9	91.48	1.17	2.50
140	.....	71.00	....	3.87	.....	105.00	....	2.34	.....	100.82	.....	2.43
129	99.0	81.04	2.29	3.37	159.4	117.78	1.46	2.18	181.7	107.09	1.38	2.41
118	.....	89.03	....	3.18	.....	124.43	....	2.18	.....	107.78	.....	2.49
107	97.5	93.73	2.25	3.11	147.9	127.41	1 59	2.23	142.2	108.99	1.61	2.61
96	100.6	98.04	2.27	3.10	143.2	126.31	1.72	2.29	134.0	109.87	1.43	2.73
74	99.4	110.14	2.22	3.09	130.5	139.98	2.02	2.41	120.4	116.92	2.18	2.90
35	106.1	137.35	2.91	3.12	130.7	170.63	2.39	2.57	117.9	138.72	2.62	3.09
−20	150.0	174.41	3.48	3.58	169.6	198.56	2.99	3.06	156.9	171.79	3.29	3.61
−52	205.6	194.59	3.51	4.12	227.1	216.37	3.07	3.60	211.7	191.33	3.40	4.23

III.—*The Plan and Location of the Dam.*—It will be seen by reference to the accompanying topographical map, that Croton river, approaching the site heretofore proposed for the dam, swerves rather sharply to the left, through a narrow gorge, into the Quaker Bridge ravine.

This ravine is bounded westwardly by a well-defined rocky promontory, of irregular height, having on its western side, and extending a considerable distance to the southward, a broad elevated swale which will be submerged when the reservoir is formed and will become the approach to the spill-ways or waste-weirs. It has been proposed heretofore to locate the dam below the entrance to the ravine.

The report gives a further explanation of the site, as shown in the map, and then decribes the alternate locations shown on the map, which are as follows:

No. 1. Angular, proposed by the engineers of the Commission, the short arm being 326 ft., and the long, main arm 1077 ft., 1403 ft. in all.

No. 2. 900 ft. radius, recommended by Mr. OLIVER W. BARNES, ex-commissioner, beginning and ending at the same points as No. 1, and 1496 ft. long in all.

No. 3. Straight. An experimental line by the Board, only 1293 ft. long, but showing large quantities and proposed by no one.

No. 4. 1200 ft. radius. Another experiment by the Board of Experts, not otherwise proposed; 1353 ft. long.

No. 5. 1146 ft. radius. Recommended by the Board of Experts, 1,693 ft. long.

We have added ground plans of dams No. 1 and 5 on our accompanying map, and have likewise added in dotted lines a ground plan for No. 2, shifting its location so as to throw it on to the most favorable ground, and shortening it 85 ft., as nearly as may be, making its length of crest, 1411 ft., as nearly as may be, or 8 ft. longer only than dam No. 1. This we have done to aid in the discussion of the comparative locations which appears elsewhere, as bringing it on more favorable ground than either No. 2 or No. 4.

After stating that the Board have given all plans attentive consideration, and that they cannot attempt to give more than conclusions, not entering into the method by which their conclusions were reached, the report continues:

As to curved and straight plans generally, without reference to the Quaker Bridge location, all authorities agree that the same principles should be followed in the designing of the profile whatever the plan, unless the curve has a very short radius, not exceeding, say, 300 ft.

In studying the transmissions of pressures through the

masonry of a dam built on a curved plan and subjected to water pressure on one side, we have made calculations of their magnitude which, while only roughly approximate and showing limits which probably are not exceeded, rather than actual values, yet have appeared to us of sufficient weight to materially aid in reaching just conclusions.

Our conclusions may be thus stated:

First—That, in designing a dam to close a deep narrow gorge, it is safe to give a curved form in plan and to rely upon arch action for its stability; if the radius is short, the cross-section of the dam may be reduced below what is termed the gravity section, meaning thereby a cross-section or profile of such proportions that it is able by the force of gravity alone to resist the forces tending to overturn it or to slide it on its base at any point.

Second—That a gravity dam built in plan on a curve of long radius derives no appreciable aid from arch action, so long as the masonry remains intact; but that in case of a yielding of the masonry, the curved form might prove of advantage.

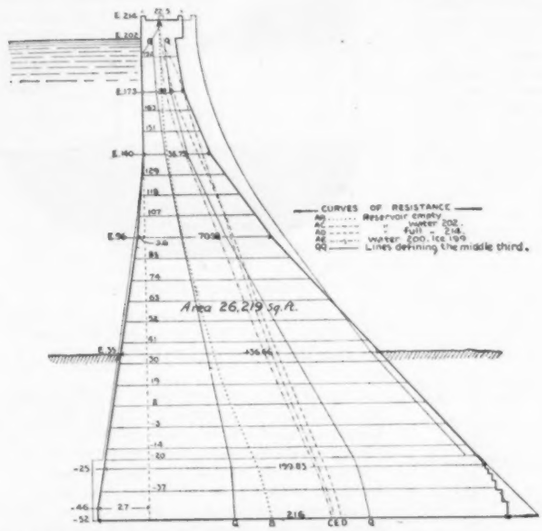
The division between what may be called a long radius and what may be called a short radius is, of course indefinite, and depends somewhat upon the height of the dam. In a general way we would speak of a radius under 300 ft, as a short one, and of one over 600 ft. as a long one, for a dam of the height herein contemplated.

Third—That in a structure of the magnitude and importance of the Quaker Bridge dam, the question of producing a pleasing architectural effect is second only to that of structural stability, and that such an effect can be better obtained by a plan curved regularly on a long radius than by a plan composed of straight lines with sharp angular deflections.

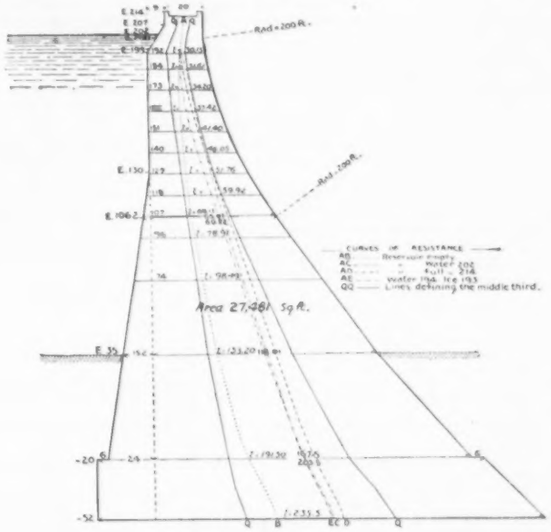
Fourth—That the curved form better accommodates itself to changes of volume due to changes of temperature.

While danger of the rupture of the masonry of the dam by extraordinary forces if built on the profile herein recommended, is in our opinion very remote, yet it exists; and because it exists, and because the curved [illegible] on a curve of 1,200 ft. radius, that the limit of allowable pressure should be approximated to in each case where the radius of curvature varied materially from that figure. The estimates of cost on different lines are, therefore, based on different cross-sections of the masonry, but all of approximately the same stability under the conditions in which they are placed.

In the study of practicable locations we have been [illegible] by the very thorough topographical maps and


CURVES OF RESISTANCE
AB ..... Reservoir empty
AC ..... " water 202
AD ..... " Full = 214
AE ..... water 200, Ice 199
QQ —— Lines defining the middle third.
Area 26,219 Sq. ft.

Plan Y.—Original Profile of Aqueduct Commission Engineers.


Rad = 200 ft.
Rad = 700 ft.
CURVES OF RESISTANCE
AB ..... Reservoir empty
AC ..... " water 202
AD ..... " Full = 214
AE ..... water 194, Ice 193
QQ —— Lines defining the middle third.
Area 27,481 Sq. ft.

Plan N.—Recommended by Board of Experts.

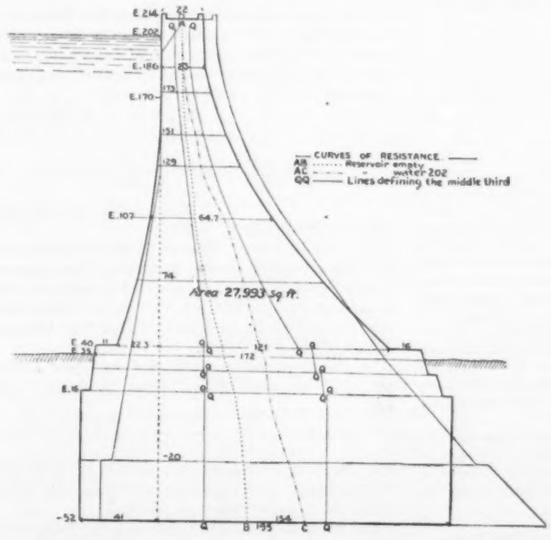
In comparing different locations of the dam, in order to discover the one which combined most effectively the advantages of economical construction and pleasing effect, we were confronted with the fact that our calculations indicate that in a dam built upon a curved plan of large radius, the bottom down-stream toe pressures are increased beyond those in a straight dam of the same section, in consequence of the length of the toe being less than the length of the face to which the pressure of the water is applied.

This increase of pressure is not exactly proportional to the decrease of length of toe, but is of such magnitude that it should not be neglected in designing the section of the dam, and it involves the necessity of increasing the mass of masonry in a certain proportion to the radius of the curvature.

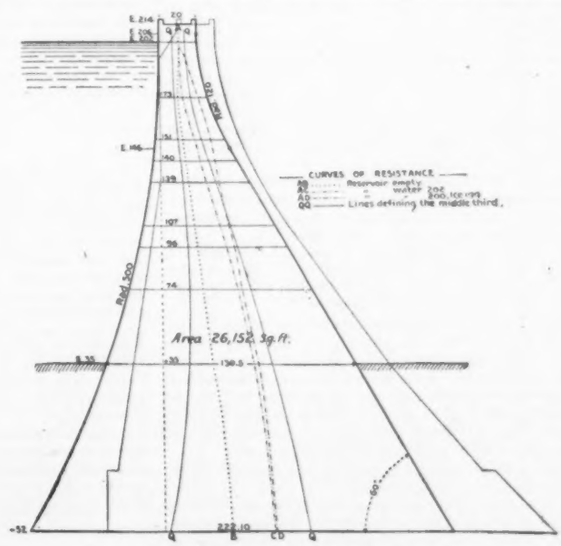
To fairly compare the cost of different locations, it seemed proper, therefore, to so modify the profile adopted by us (N) which fulfills the conditions of stability is more pleasing to the eye, better satisfies the mind as to the stability of the structure and more readily accommodates itself to changes of temperature, we think that it should be preferred in any case where it would cause no great addition to the cost.

records of borings furnished us by your engineer, and have had estimates of quantities made on several locations. A few of these have sufficient value to be presented to you.

The estimates of quantities on these locations have been made by your engineers from the topographical maps and records of borings. They are approximate only, but being all computed on precisely the same basis



Plan X.—Proposed by Board of Public Works Engineers.


CURVES OF RESISTANCE
AB ..... Reservoir empty
AC ..... " water 202
AD ..... " 200, Ice 199
QQ —— Lines defining the middle third.
Rad 500
Area 26,152 Sq. ft.

Plan Z.—Proposed by A. Marichal, C. E.

ALTERNATE CROSS-SECTIONS OF THE QUAKER BRIDGE DAM

Showing their comparative stability under various conditions.

(The cross-section of Recommended Plan N is shown in a fine line on each of the other sections).

afford, we believe, a sufficiently accurate comparison of the relative amount of work required on the several plans, but they do not include the cost of providing the carrying of the water of the river past the work during construction, nor that of other items of expenditure which are common to all plans. The prices assumed are, moreover, not based on a critical examination of the cost of work in that particular locality, as no investigations have been made, so far as we can learn, to discover where, in that vicinity, suitable stone for the structure can be procured. In the absence of such data, we have been guided in our estimates by our general opinion of the value of such work in such a locality.

The location No. 1 being the angular line recommended by your Chief-Engineer, is evidently selected with a view of securing the minimum of masonry obtainable by

crossing the deep valley by straight lines. From that point of view, the location is a judicious one. Applying to it the modified profile N, which fulfills the conditions, for a curve of infinite radius, on a straight line, the estimate of quantities and cost is as given in the accompanying table.

The location No. 2 on a curve of 900 ft. radius, appears to have been selected with the object of following, as far as practical, the promontory, and at the same time connecting by a curved line, the extremities of location No. 1. Applying to it the modified profile which fulfills the conditions for a curve of 900 ft. radius, is as given in table.

By building the dam on this location, therefore, its length would be increased 7 per cent., the mass of masonry 10 per cent., and the cost 11.4 per cent. over location No. 1.

It seemed desirable to know whether there would be any economy in crossing the valley by the shortest line between the hills, and we therefore had an estimate made on location No. 3, as given.

It appears, therefore, that by taking the shortest straight line practicable, while the length of the dam is decreased 10 per cent., the mass of masonry is increased 16 per cent. and the cost increased 16.4 per cent. over location No. 1.

With the view of finding in this vicinity a location on a curve of large radius which would give less length of dam at the top than either No. 1 or No. 2, and would strike the easterly shore of the lake more nearly at right angles than either of these locations, several trial lines were estimated on. The location which appears to best fulfill these conditions is designated on the map as No. 4 and is on a radius of 1,200 ft.

On this location the cost is apparently slightly in excess of that on location No. 2, but it is preferable to No. 2 in that it is 143 ft. shorter at the top and is moreover better located on the east bank of the river.

For the reasons hereinbefore given, and especially for the greatly superior architectural effect, we consider that the location on the curved line No. 4 is to be preferred to that on the angular line No. 1.

From a strictly economical point of view, however, the location on line No. 1 is probably the best that can be found as the quantity of masonry will be less and consequently the cost, irrespective of the expenditure needed for protection against the water of the river during construction, will be less by from $300,000 to $500,000 than by any line continuously straight or curved from end to end across the valley, which we have examined.

But the chief difficulty in building the dam will be in the construction of that portion of it which lies below the present river bed, in consequence of the cost, both in time and money, of the provisions for passing the water of the river by and over the work during the progress of construction, and the keeping of the pit from 80 to 90 ft. deep, free from water.

In general it may be assumed that of two locations equally favorable in other respects, that one is to be preferred in which the amount of work to be done below the river bed and the time to be occupied in its construction is materially less.

With this in mind, there appears to be a very favorable location for the dam further up-stream at the entrance of the ravine, on the line designated on the map as No. 5. It starts on the promontory at the same point as No. 1 and follows a curve of 1,140 ft. radius to a point on the east bank about 600 ft. north of the north end of No. 1.

A few borings made in 1884 and several additional ones made within the past month give indications that in general the rock lies favorably for the construction of the dam on this line. The deep valley under the river bed is much narrower than it is further down the gorge, thus making a material reduction in the items of excavation and masonry below the river level.

The length of the crest on this location is greater than on the other locations, but the line crosses the contour lines of the rock surface more nearly at right angles and therefore probably will secure a good foundation with the least amount of rock excavation.

It presents a water face more nearly tangential to the axis of the lake and therefore better fitted by position to withstand the impact of the floating masses.

We believe also that in case it should be thought advisable to pass the waters of the river through a tunnel during construction, this location would permit the driving to tunnel on a shorter and in other respects more favorable line than would the other locations.

When these facts are fully appreciated and weighed in connection with the possibilities of serious delays and losses by damage from freshets while the work is still below the river surface, the great importance of a more thorough examination and analysis of this location will be seen. Applying profile N, the estimated cost on this location, designated on the map as No. 5, is as given.

The cost of this location will therefore, according to the best obtainable data, be $347,626 greater than on location No. 1, but for that portion of the dam below the river level the cost will be $204,084 less than on location No. 1, and $440,958 less than on location No. 4.

This may become an important factor in the final determination of the location of the dam. If these figures of the cost below the river level should be confirmed by further examination, we are of the opinion that this location No. 5 will be greatly to be preferred to any of the other lines.

Comparative Quantities, Length and Cost of Various Dams.

	Price per cu. yd. or ft.	No. 1. Aqueduct Engineers		No. 2. 900 ft. rad. O. W. Barnes.		No. 3. Straight dam		No. 4. 1200 ft. radius		No. 5. 1146 ft. rad. Recommended.	
		Cu. Yds.	Cost	Cu. Yds.	Cost	Cu. Yds.	Cost	Cu. Yds.	Cost	Cu. Yds.	Cost
Excavation b'low river level.....	$1.00	268,000	268,000	318,000	318,000	348,000	348,000	315,000	315,000	277,188	227,188
Rock excavation.	2.00	40,671	81,342	60,876	121,752	58,938	117,876	58,038	117,876	63,703	127,406
Masonry below elevation 35.....	6.00	178,671	1,072,026	211,786	1,270,716	232,000	1,392,000	209,650	1,257,900	151,459	908,754
Masonry between el'vation 35 and 100.....	6.60	162,563	1,072,850	163,959	1,082,129	183,750	1,212 750	177,719	1,172,944	161,831	1,068,085
Masonry between el'v'tion 100 and 150.....	7.00	84,642	592,494	93,771	656,397	96,071	672,497	98,962	692,734	128,459	899,213
Masonry between el'v'tion 150 and top.....	8.00	88,244	695,952	95,997	767,976	83,453	667,624	86,125	689,000	111,243	889,944
Ld'eal feet coping	30.00	1,403	42,090	1,406	44,880	1,253	37,890	1,353	40,590	1,693	50,790
Total Masonry and Cost.....		514,110	$3,824,754	565,513	$4,261,850	595,274	$4,448,637	572,456	$4,286,044	552,992	$4,171,380
Details of assumed S'cti'n of equal stability	thickness at 35	128.2 ft.		135.2 ft.		128.2 ft.		133.2 ft.		133.2 ft.	
	thickness at—52	224. ft.		239.5 ft.		224. ft.		135.5 ft.		235.5 ft.	
	Sectional area	26,509 sq.ft.		27,873 sq.ft.		26,509 sq.ft.		27,481 sq.ft.		27,481 sq.ft.	

CONCLUSIONS.

In view of the premises and pursuant to our instructions and believing that the dam will be more pleasing in appearance and better able to resist extraordinary forces if built on a curved plan, and bearing in mind that an excessive thrust in the direction of the curve cannot be produced until the force of gravity has been overcome, and that the profile N is so proportioned that more than twice the greatest pressure exerted by any conceivable ordinary force is necessary to overcome the resistance of gravity, we recommend the adoption of the profile or cross-section N and of a curved plan on a radius of about 1,200 ft, as hereinbefore described, and we advise that the exact line be determined after further borings shall have established the most desirable location on the conditions prescribed.

It should be added in conclusion that the form and dimensions herein recommended for adoption are prescribed on the assumption that the structure shall be well founded and that its material and workmanship shall be of the first class in their several kinds.

Respectfully submitted.

JOSEPH P. DAVIS,
J. J. R. CROES,
WM. F. SHUNK.

CORRESPONDENCE.

Determining Center of Mass of Earthwork.

Seattle, Lake Shore & Eastern Ry.
SPOKANE FALLS, W. T., Oct. 22, 1888.

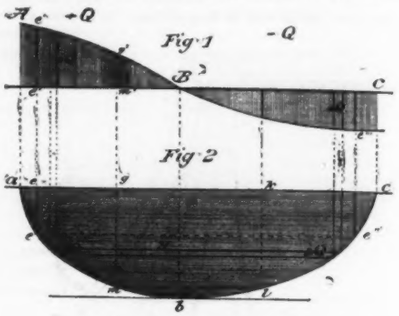
EDITOR ENGINEERING NEWS:—

Referring to the inquiry in your issue of September 22, as to some quick method of finding the center of mass. I beg to illustrate a graphic method which is very simple and may be made accurate if desired.

Fig. 1 represents the profile where the cut $A\,B$ is to be removed to fill $B\,C$.

Let the consecutive volumes from A be represented by ordinates and measured from a line $a\,e$ Fig. 2. vertically under the end of each volume, for example, volume $A\,e$= the ordinate $e\,e$; volume $A\,m' = g\,m$ etc.

If cut is designated positive and fill negative, these ordinates, if connected, form a curve $a\,e\,m\,b\,l\,e''\,c$, which plainly shows the distribution of the mass.



Determining Center of Mass.

Any horizontal line through this curve intersects it at places where the cut is equal to the fill as for instance the horizontal line $e\,e''$ shows cut $A\,e$ = fill $C\,e''$.

If an infinite small volumn $\triangle\ Q$ is selected in the cut, the corresponding horizontal line in Fig. 2 locates $\triangle\ Q$ in the fill. The quantity $\triangle\ Q$ multiplied with its distance of haul gives the moment.

Thus the moment $\triangle\ M = \triangle\ Q.\ y$ = the area of the rectangle with $\triangle\ Q$ as height and y as base.

The sum of these or $\Sigma \triangle\ M = \Sigma \triangle\ Q.y$ = the area inclosed by the horizontal line and the curve $a\,e\,m\,b\,l\,e''\,c$.

This moment or area multiplied by the price per yard per 100 ft. gives the haul allowance.

If the distance from centre of gravity of cut to centre of gravity of fill be desired, it is easily found from

$$Q.\,X = M = \text{area}\ a\,b\,c$$

$$X = \frac{M}{Q}$$

If free haul is allowed for, this can be taken out by inserting a horizontal line = the length of free haul as $m\,l$ in Fig. 2, the sum of the areas on either side of the ordinates $m\,g$ and $l\,k$ as then the required moment for that which is to be paid.

Yours truly, M. STIXREED.
Asst. Engr. S. L. S. & E. Ry.

The Cross-Section Mnemonic.

ROLLA, Mo., Oct. 20, 1888.

EDITOR ENGINEERING NEWS:

Because of several letters of inquiry received concerning an article headed as above, which appeared in the NEWS, Vol. XX., No. 39., I beg to be permitted to correct a numerical error in one of the cross-section computations used there to illustrate the application of the principle.

In the cross-section indicated as "part cut and part fill", the sum of the "down products" in the cut

$$\frac{0}{9} \quad \frac{+20}{29} \quad \frac{+7}{10} \quad \frac{0}{5}$$

was given to be 200, when it should have been 235, the product 7×5 having been omitted. The correct area then is + 74 instead of + 91.5.

For while the first cross-section given turns out to be a *gauche* polygon, the area +510.5 *is* its true area, in that it is the area which would be given by the *planimeter* (or any other integrator) by which the boundary was traced *as a polygon*.

In point of fact this cross-section is an impossible one, and it is unfortunate that it should have been chanced upon for this purpose.

Indeed as first written the + 3 was + 8, which was copied wrong and then computed with the above result, and if I may be now permitted to make that correction, the section would appear:

$$\frac{0}{9} \quad \frac{+27}{36} \quad \frac{+21}{18} \;\Big|\; \frac{+16}{0} \;\Big|\; \frac{+9}{7} \quad \frac{+8}{14} \quad \frac{+12}{21} \quad \frac{0}{9}$$

Giving for the "up products"

$$\begin{aligned} (27 + 12) \times 9 &= 351 \\ (18 + 7) \times 16 &= 400 \\ 21 \times 36 &= 756 \\ 21 \times 8 &= 168 \\ 14 \times 9 &= 126 \\ &\overline{1,801} \end{aligned}$$

and for the "down products",

$$27 \times 18 = 486$$
$$7 \times 8 = 56$$
$$14 \times 12 = 168$$
$$710$$

The true area is, therefore, + 545.5.

In the operation there are only 8 multiplications. The number of products can always be reduced, too, in this way; and moreover since each product may have one of its factors divided by 2 (because their sum gives the double area) the work may be further reduced.

This method of computing cross-sections is not the result of a class room *mathematical fever*, as the editor appears to believe it to be, but developed itself in the field before irregular sections. It has demonstrated its utility (to the writer at least) by service in giving sections for 25 miles of as rough country as one cares to cross-section, and particularly through old "borrow pits" and "spoil banks", in paralleling another road bed for 5 miles on the Kansas City & Birmingham Railway in Alabama.

I have used it for several years on actual construction and have published it believing that engineers will find it not merely interesting but *practically useful*.

While I am opposed to innovations, simply as such, as much as is the editor; I have myself felt something to be needed in the question of irregular cross-sections and have found it in the method which I have presented, and believe that I will not stand alone, the editor to the contrary notwithstanding.

W. H. ECHOLS.

[We cheerfully give space to Prof. ECHOL'S corrected example, and dissent from our previously expressed view as to his ingenious method of computing irregular cross-sections without plotting, by a mnemonic rule. But we must be allowed to repeat our remark that the fact of such an error occurring undetected in a single illustrative example, is the best of all proofs that such cross-sections should in all cases be plotted. In practical work 8 is still more likely to be mistaken for 3, or read 3 if written 8; and the check upon the correctness of the notes which is obtained by plotting is one which, in our judgment, can never be safely dispensed with for irregular cross-sections, and one which is highly desirable for regular sections as well. That the incorrect area is one which would have been given by the planimeter likewise, had it been applied mechanically to the computation of a *gauche* polygon, is true; but the point is, that no one would be guilty of such an absurdity with the plot before him showing two areas instead of one, whereas in the notes there is nothing to reveal the danger.—ED. ENG. NEWS.]

Wood Treatment Tests.

EAST ORANGE, N. J., Oct. 23, 1888.

EDITOR ENGINEERING NEWS:

Referring to the article on Wood Treatment Tests in your issue of Sept. 1, last, I beg to suggest the desirability of your trying your powers of persuasion toward securing, if possible, the full details of treatment needed, the data upon which the result of these recent experiments at the dead oil creosoting works mentioned are based.

The subject of wood preservation has become one of such great and growing importance that full and reliable data relating to any particular process of treatment are of absorbing interest to the engineering profession, to the enlightment of which your valuable journal has so well catered; and I am therefore, the more surprised that so much space should have been given to an article containing so little "Engineering News" of value on the subject as the one in question.

Examples are numerous, both of the successes and failures attending the impregnation of wood with creosote oils, whether derived from wood or coal distillation, so that the mere mention of bare results obtained, whether good or bad, without giving all the conditions of the treatment is of no real value and well calculated to mislead the ill-informed and unwary.

The Weather of the United States for the Month of June, 1888.

[As respects the elements of most interest to engineers.]

According to special returns from the Chief Signal Officer of the U. S. Army.

STATION.	Temperature, Degrees Fah.				Wind Velocity. Miles per hour.			Precipitation, Rain and melted snow. Inches.		
	Average	Max.	Min.	Range.	Average	Max.	Direction, Max.	Total.	Heaviest in 24 hours.	No. rain days.
NORTHERN CITIES.										
Northfield, Vt.	63.5	89.2	35.1	54.1	7.8	30	NW & W	6.17	1.47	15
Portland, Me.	63.0	96.5	45.0	51.5	6.9	27	S	2.79	1.22	11
New York City.	71.4	96 2	52.2	44.0	9.1	48	NW	1.68	0.64	7
Pittsburg, Pa.	71 8	95 2	41.4	53.8	6.4	28	SW	2.22	1.11	11
Chicago, Ill.	67.4	90.0	43.0	47.0	10.2	30	SW	1.66	0.97	8
Omaha, Neb.	70.0	96.2	46.4	49.8	8.6	47	S	3.86	1.68	9
St. Paul Minn.	67.0	88.7	41.0	47.7	6.4	36	W	1.95	0.52	10
Duluth, Minn.	53.8	85.0	38.5	46.5	5.9	28	NE	5.54	1.81	17
Bismarck, Dak.	63.3	95.0	30.6	64.4	13.2	48	N	5.77	2.54	18
Average.	65.7	92.4	41.5	50.9	8.3	36.		3.51	1.33	12.
SOUTHERN CITIES.										
Washington City.	73.0	94.0	52.0	42.0	5.0	36	NW	3.53	1.41	9
Louisville, Ky.	75.7	98.5	51.5	47.0	7.1	26	SW	3.28	1.23	11
St. Louis, Mo.	73.2	82 4	65.0	17.4	14 4	42	W	8.09	4.64	14
Savannah, Ga.	77.1	90.8	60.0	30.8	6.4	28	NW	2 59	0 53	10
Leavenworth, Kan.	72.2	96 2	47.8	48.4	7.3	30	S & NW	7.77	2.58	15
Jacksonville, Fla.	79.2	95 8	63.5	32.3	5.9	30	SW	2.92	0.78	16
Chattanooga, Tenn.	74.6	94 0	52.5	41.5	4.4	32	SW	3.31	2.13	13
New Orleans, La.	77.3	92.3	66.5	25.8	6.8	36	S	9.09	4.44	13
Memphis, Tenn.	75.4	93.6	53.8	39.8	4.0	54	NW	4.42	1 33	15
Palestine, Tex.	77.7	94.4	64 6	30.8	7.3	34	SE	5.80	1 81	12
Average.	7 .5	93.2	57 6	35.6	6.8	34.8		5 07	2 08	12.8
WESTERN CITIES.										
Helena, Mont.	58.8	90.0	39.5	50.5	7.9	40	E	1.87	0.38	20
Port Angeles, W. T.	55 4	68.1	38.0	30.1	5.1	27	W	2.63	0.68	17
San Francisco, Cal.	61.0	79 9	53.2	26.7	11.9	35	W	0.27	0.10	8
Salt Lake City, U.	68.8	92.7	45.1	47.6	6.9	40	SE	0.98	0.51	5
Denver, Col.	68.4	97.7	41.0	56 7	8.0	44	NW	0 29	0 10	9
Yuma, Ariz.	85.6	106.9	60.0	46.9	7.3	32	W	0	0	0
Santa Fé, N. M.	67.1	87.0	41.5	45.5	7.4	30	E & S	0.16	0.06	6
Average.	66.4	83.9	45 5	43.4	7.8	35.		0.88	0.23	9

Not the least important of these conditions are the particular process employed, the preparation of the timber for the antiseptic and the quantity and quality of oil with which it has been impregnated. Not finding any allusion, even, to these vital points, with regard to any of the specimens referred to in the report of these tests, I sought to inform myself thereon through courteous personal inquiries directed to the Chief Engineer of the railroad who is reported to have instituted these experiments, and the creosoting company by whose engineer they appear to have been conducted. But I am sorry to say that, though return postage was enclosed for reply, none has yet been received! Hence this appeal, on behalf of a suffering profession, for the stern interference of your more potent persuasive powers in the premises. Having given us part of the fact, supporting a particular conclusion, let us now have the whole of them to enable one to judge for himself.

Such withholding of information, so essential to the forming of an intelligent judgment, may perhaps be considered shrewd business policy, but it is not calculated to recommend the reliability and efficiency of work turned out by any concern practicing it to the confidence of the business public generally, and of engineers particularly. Indeed I feel justified in saying, as the result of considerable personal observation, that any disrepute into which the creosote processes of wood preserving have fallen, is chiefly, if not wholly, due to the "creosotors" themselves, in turning out work below well known requirements, when the very best class of work, which is none too good, is within their reach, and will always meet with proper appreciation.

A complete preservation of wood for construction purposes by any process is invaluable, and any treatment which insures this to any great degree will surely win its way to favor and dividends, while anything attainable short of it will soon run its course and meet the fate it deserves.

Yours truly, F. C. PRINDLE.

[We must refer the letter of our correspondent to the engineers whose report is commented upon. We cannot suppose that they meant to cast discredit upon a process differing from their own. But with works very fully equipped for certain treatment of wood and the managers experienced in this treatment, it is possible that the samples submitted to an entirely different process may not have had the fairest handling possible under different conditions, and the engineers owe it to a much interested public to fully explain all the actual conditions.—ED. ENG. NEWS.]

Sluice Gates for Dams.

BRIDGEPORT, Conn., Oct. 29, 1888.

EDITOR ENGINEERING NEWS:

In regard to query of H. TILLY BROWN, C.E., as to sluice gates for masonry, timber, earth or other dams for irrigation purposes, or for waste or head gates for mill purposes, water-works, etc., I would answer as follows:—

For the above purposes, or for admitting water into gate chamber from reservoirs at different elevations, we use the rectangular gate of such dimensions as occasion may demand, from 20 in. to 8 ft. square. The 6 to 8 ft. gates are made double, as 3×6 ft. or 4×8 ft. The frame is cast iron made in four pieces, planed inside and bolted together. The gate is cast-iron, as is also the shaft, cast in one piece, blades being cast on the shaft and the edges planed. This makes a strong, durable and watertight gate, either when set in masonry or bolted to timber.

It is operated by a shaft passing verti through a recess made in the dam, about 12 square, and a cast-iron stand placed on the to the dam, with a worm gear. The blade of the gate is 2 ins. longer on one side than on the other, making it easy to work under any head. In our hydraulic work we have used about 100 of these gates of all sizes.

Many mills have used these gates for head and waste gates, or sluice gates. There is no patent on this gate whatever. The cost of the gate, shafting, stand, worm-gear, etc. complete, is about 6 cts. per pound; or, about $160 for a 30×30 in. gate. I have used this gate about 15 years and know what it is, and write simply for the benefit of other hydraulic engineers.

Yours Respectfully,
B. H. HULL,

MADISON, CONN., has eleven railroad grade crossings. Four of these are double crossings and nine bridges would have been required. The town has adopted plans, approved by the railroad company, by which two $30,000 bridges are done away with, one crossing abolished, and a new highway laid down. The railroad company is to build all the bridges and pay part of the cost of the highway, and the town is relieved of nearly all expense, except some right-of-way.

ENGINEERING NEWS
AND AMERICAN RAILWAY JOURNAL

Published Weekly at Tribune Building, New York.

Vol. XX. Saturday, November 3, 1888.

D. McN. STAUFFER, A. M. WELLINGTON. EDITORS.

GEO. H. FROST. - - - - - BUSINESS MANAGER.

Subscription. — UNITED STATES AND CANADA, $5.00 *per Year; $2.50 for Six Months; $1.50 for Three Months; Single Copies,* 12 *cents.* FOREIGN COUNTRIES, $6.56 *per Year, or* 3 *cents per number additional.*

Drawings and Photographs *of all new engineering works or designs, large or small, of interest from their magnitude, novelty or originality, as well as newly adopted* **Standard Plans** *for engineering structures or details, rolling stock, etc., are always desired for early publication. Also,* **Brief Technical Notes** *of the cost or manner of executing work, tests of materials, machines or other new devices, and* **News of New Construction** *of all kinds.* **Letters** *for publication must be accompanied by the name or card of the writer.*

Coming Technical Meetings.

Engineers' Club, Philadelphia, Pa.—Regular meeting, Nov. 3. Secy., Howard Murphy, 1122 Girard St.

Civil Engineers' Society of St. Paul, Minn. — Regular meeting, Nov. 5. Secy., Geo. L. Wilson, City Hall.

Engineers' Club of Kansas City, Mo.—Regular meeting, Nov. 5. "Electrical Railways", T. F. Wynne. Secy., Kenneth Allen, Y.M.C.A. Building.

American Society of Civil Engineers, New York.—Regular meeting, Nov. 7. "Report of Committee on the proper Relation to each other of the Sections of Railway Wheels and Rails." Secy., John Bogart, 127 E. 23d St.

Western Society of Engineers, Chicago, Ill.—Regular meeting, Nov. 7. Secy., L. E. Cooley, 171 La Salle St.

Civil Engineers' Club of Cleveland, O.—Regular meeting, Nov. 13. Report on Mechanical Engineering. Secy., James Ritchie, Case Library Rooms.

National Association of Brick Manufacturers.—Annual meeting at Memphis, Tenn., Nov. 13, 14, 15.

New England Railroad Club.—Next meeting at Boston & Albany R. R. passenger station, Boston, Mass. Nov. 14.

Engineers' Society of Western Pennsylvania, Pittsburg, Pa.—Regular meeting, Nov. 20. Secy., S. M. Wickersham, Penn Building.

Boston Society of Civil Engineers, Boston, Mass.—Regular meeting, Nov. 21. Secy., S. E. Tinkham, City Hall.

New York Railroad Club.—Next meeting, Nov. 22, at 113 Liberty St., New York City.

WE rejoice to learn that the American Society of Civil Engineers has properly recognized the long and distinguished professional career of Col. JULIUS W. ADAMS, ex-President, by electing him an Honorary Member of the Society. The Society is fortunate in having still among its active members—active in every sense—three of the original band of 12, who founded the Society in 1852, 36 years ago, Col. ADAMS, JAS. B. FRANCIS and Gen. GEO. S. GREENE, both of the two latter being likewise ex-Presidents, and both of them being, it seems to us, eminently entitled to this distinction, not only as founders and ex-Presidents, but for their professional career alone. The same seems equally true of one other ex President, Hon. WM. J. MCALPINE, in all except that he was not strictly among the founders of the Society, having been elected a member Feb. 2, 1853, or three months after its first organization. These four, however, exhaust the list of living ex-officers who were members of the Society prior to its reorganization in 1867, after nearly 14 years practical suspension. The only other ex-President of great age and eminence is the venerable HORATIO ALLEN, who ran the first locomotive ever run in America, and is already an Honorary Member.

There seems the more reason why these four eminent engineers should all be chosen honorary members, that the honorary list is now both short and one-sided. It contains only 7 names in all, 3 of whom are army officers, Gen's. DUANE, NEWTON and WRIGHT; the others being JOHN ERICCSON, Sir JOHN HAWKSHAW and MONCURE ROBINSON, of Philadelphia; the last of whom was, with one exception (HENRY BURDEN, of Troy, N. Y.) the first Honorary Member ever chosen, in March, 1853.

The only other members still living dating from the '50s are THOS C. MEYER, of New York, MCREE SWIFT, of New Brunswick, N. J., and WM. D. PICKETT, of Wyoming, a short list indeed. One only dating from this early period is numbered among the dead. The handful of others failed to renew their membership when the Society was reorganized.

THE topic of paramount interest during the past week in Southern railway circles has been the great deal by which the Richmond & West Point Terminal secured control of the Central R. R. & Banking Co. of Georgia. Atlanta is pluming herself over the promise of JOHN H. INMAN that at an early day the much desired union depot shall be built. Other cities, interested in some of the extensions which the Central of Georgia was building or backing, are anxiously waiting for some sign of what the policy of the Richmond & West Point Terminal managers is to be toward these new roads projected and under way. A report that President ALEXANDER would be removed from the head of affairs of the absorbed company to make way for his predecessor, W. G. RAOUL, now president of the Mexican National, has probably as little foundation as the statement that the minority stockholders of the Central of Georgia will appeal to the courts to prevent the consolidation. It is to be remembered that the grand purpose of the consolidation is to effect an extension of area of the Richmond Terminal, and that the two systems consolidated were hardly to be considered as competitors before, except indirectly at a few points. It is for the interest of the controlling company, therefore, to develop the earning capacity of its new acquisition to as great an extent as possible; and should an attempt be made to avoid this, for the chance of securing greater profits by making the controlled company merely a tributary to the other lines controlled by the Terminal company, the minority stockholders have a remedy in the courts. The deal has of course started the usual avalanche of surmises as to further probable consolidations; and it has been guessed "on good authority" that the Richmond Terminal would follow up its present master stroke by swallowing up the Louisville & Nashville, Queen & Crescent and Plant Railway systems, as well as various other smaller fry by way of a relish. For these conjectures the main foundation is the general tendency toward consolidation everywhere, a tendency which has been greatly strengthened by the destructive competition which has been the rule during the present year. It is, however, reported that nogotiations are in progress for the control of the Atlantic Coast Line system; and as the two companies have been working in harmony lately in the matter of the new terminus at Norfolk, Va., it is not unlikely that the deal may be effected.

THE interior line of water-ways, suggested for military purposes by the late excursion of Admiral LUCE, while not altogether utopian, has several serious objections from a practical stand point. A route could doubtless be opened, parallel to and well within our Atlantic coastline, from Boston to the mouth of the Rio Grande; and in fact this route is now open to vessels of light draught for a considerable part of the way, say from Providence, R. I., to Beaufort, S. C. But it is utterly valueless for the transit of even the lightest modern gunboat; and the hundreds of millions of money required to deepen and widen existing channels and to create new ones so as to complete the chain of communication, could be better expended elsewhere. In the first place, a foreign war might be carried on in winter, and these canals in our Northern States would be about as valuable then as dry land for the passage of war vessels. And secondly, it would be much better to spend this capital in building war-ships that would not have to sneak around in the back yard to escape capture from stronger ships. Such an interior route, of more modest proportions, would doubtless be very useful and valuable to our coast-wise commerce, and there are many and strong arguments in its favor from this point of view. But for war purposes we want strong, well-armed forts in our harbors, and strong modern war-ships along the outside of our coastline, both fully able to cope with any interloper that may put in an appearance. Taking the estimates for the Delaware and Chesapeake, the Cape Cod and the Florida ship canals alone, we would have an aggregate of about $75,000,000 to $90,000,000. This sum would construct and arm a very respectable fleet of war ships that would be immeasurably more useful in an emergency at home and have a value abroad in the meantime.

THE registration in New York and Brooklyn affords a means of gauging the correctness of the estimates of probable future growth of those cities which we published in our issues of April 28, *et seq.*, 1888. It shows an astonishing rate of increase of population, if it can be accepted as a correct gauge of growth of population, far in excess of what it then seemed reasonable to estimate, the figures being as follows:

Total registration		Increase no.	p.c.	Equivalent decennial rate
NEW YORK				
1880	217,023			
1884	240,906	23,883	11.00	29.82
1888	286,657	45,751	19.00	54.45 av. 41.60
BROOKLYN				
1880	113,932			
1884	127 010	13,078	11.49	31.22
1888	156,385	29,375	23.13	68.23 av. 48.57

The actual increase for the whole eight years has been 32.09 per cent. in New York, and 37.26 per cent. in Brooklyn, but the equivalent decennial rate is the most significant, enabling us to compare directly with the actual records of the past which we gave in our issue of April 28, as follows:

	New York	Brooklyn
1790-1800	53.0	27.7
1800-10	44.1	44.7
1810-20	23.4	34.7
1820-30	53.3	83.6
1830-40	50.9	131.8
1840-50	58.8	191.7
1850-60	59.1	50.4
1860-70	17.6	42.4
1870-80	22.5	42.8
1880-90 (est.)	41.60	48.57

This shows that New York has again taken a great start, to something like its old rate of growth prior to the ante-elevated days when city transportation was so serious a problem. The elevated lines were opened in 1878-9, but their effect had hardly begun to be felt in 1880, when the last census was taken. The recent growth is gratifying, but cannot continue long (i. e., more than twenty years at most), as the available room on the island is getting very much restricted, and the island as a whole has the densest population of any equal area on the globe.

WE know of no reason why the registration should not be a fair index of the growth of population. There is no exceptional interest in the election this year, over what there was 4 and 8 years ago; rather less if anything, and a soaking all-day rain on the last [illegible] of re-

ILLUSTRATIONS ACCOMPANYING THE REPORT OF THE BOARD OF EXPERTS ON THE PLANS FOR THE

QUAKER BRIDGE DAM

ACROSS THE

Croton River, New York.

JOSEPH P. DAVIS,
J. J. R. CROES,
WM. F. SHUNK. } Board of Experts.

Comparative Toe Pressures and Factors of Safety.

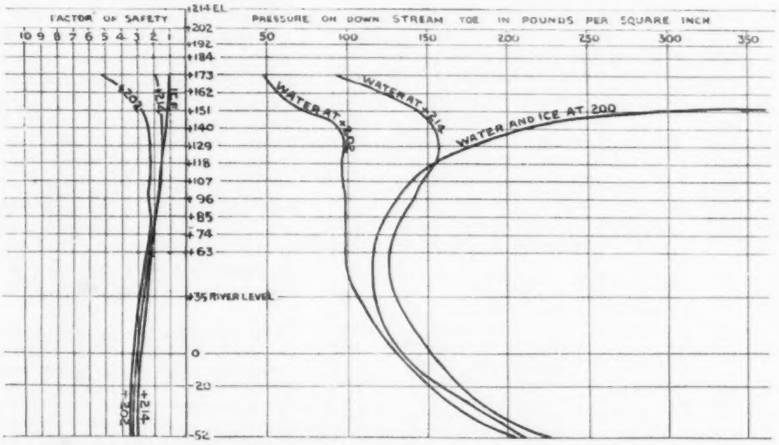

FACTOR OF SAFETY
PRESSURE ON DOWN STREAM TOE IN POUNDS PER SQUARE INCH
WATER AT +202
WATER AT +214
WATER AND ICE AT 200
+35 RIVER LEVEL

Diagram showing the Toe Pressures and Factors of Safety for the Aqueduct Commission Plan Y, originally proposed, under varying Conditions of Service.

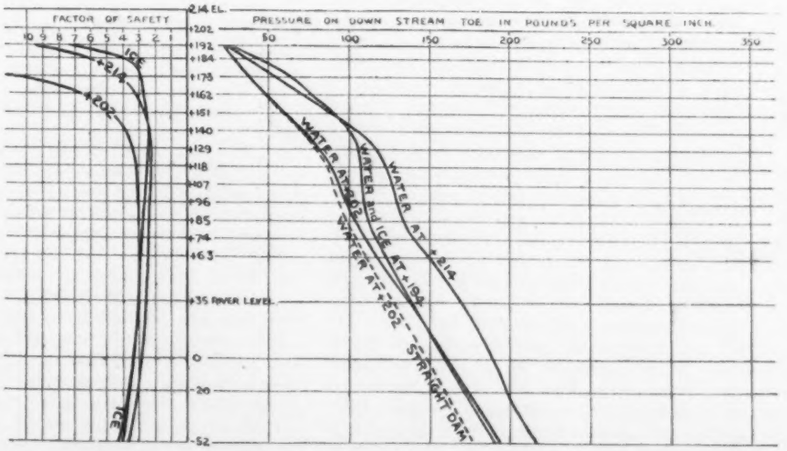


Diagram showing corresponding Toe Pressures and Factors of Safety for the Recommended Plan N, 1,146 ft. radius; (Calculated for 1,200 ft. radius). Corresponding computed Toe Pressures for a Straight Dam of same section shown by dotted line.

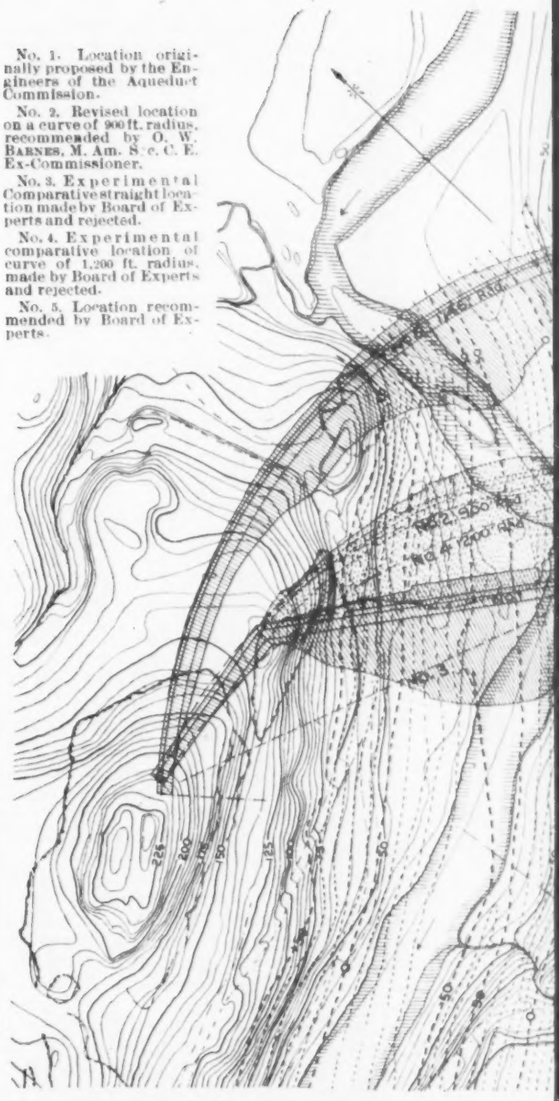
No. 1. Location originally proposed by the Engineers of the Aqueduct Commission.

No. 2. Revised location on a curve of 900 ft. radius, recommended by O. W. BARNES, M. Am. Soc. C. E. Ex-Commissioner.

No. 3. Experimental Comparative straight location made by Board of Experts and rejected.

No. 4. Experimental comparative location of curve of 1,200 ft. radius, made by Board of Experts and rejected.

No. 5. Location recommended by Board of Experts.



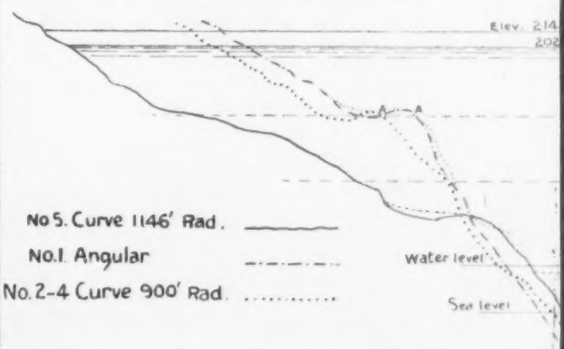
Topographical Map of the Site of Quaker Bridge Dam, ac
Dam 1, as originally proposed by the Aqueduct Comm
Board of Experts; and (by Dotted Lines) Dam 2-4.

Reduced photographically from the original

Surface Contours shown by solid lines at 5 ft. intervals, every fif
Underlying Rock Contours shown by dotted lines, at 10 ft. inte

[The dotted ground-plans for Dams 1 and 5 have been added by us, t
of the same scale as the maps which accompany the Report of the Board
of the same radius as No. 2, but on a location approximately more nearl
mechanically from that of No. 1 by laying off radially distances inter
as No. 1].

The earthy material overlying the rock is in the nature of hard



Longitudinal Profiles of Dar

Profiles of Dams 1 and 5 reproduced from the separate profiles accor
the contour map.

The profile is taken on the face line: consequently the distance acro
by 8 to 10 per cent.

EPORT OF THE
S FOR THE

E DAM

K.

of Safety.

PER SQUARE INCH
250 300 350
AT 200

for the Aqueduct Com-
of Service.

PER SQUARE INCH.
250 300 350

rs of Safety for the Re-
adius). Corresponding
wn by dotted line.

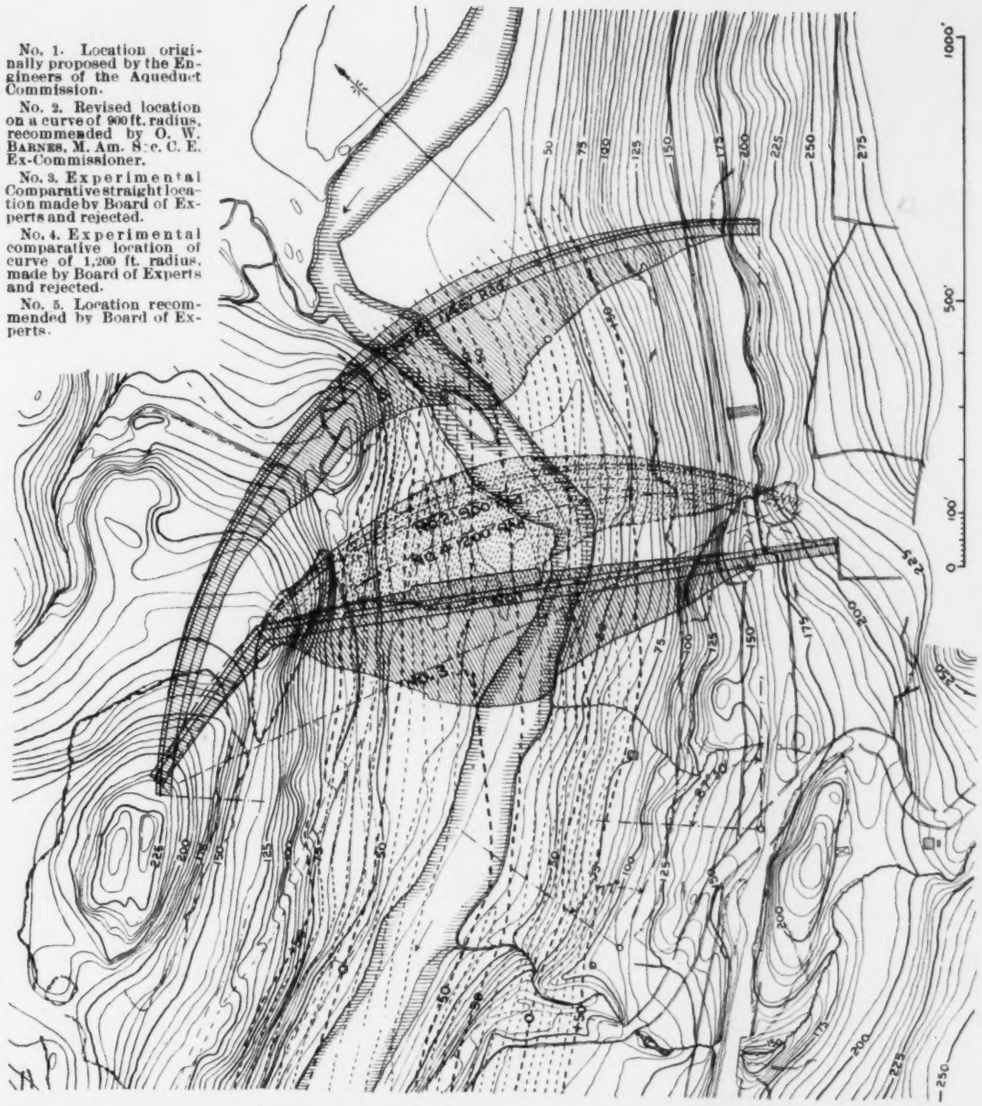
No. 1. Location originally proposed by the Engineers of the Aqueduct Commission.

No. 2. Revised location on a curve of 900 ft. radius, recommended by O. W. Barnes, M. Am. Soc. C. E. Ex-Commissioner.

No. 3. Experimental Comparative straight location made by Board of Experts and rejected.

No. 4. Experimental comparative location of curve of 1,200 ft. radius, made by Board of Experts and rejected.

No. 5. Location recommended by Board of Experts.

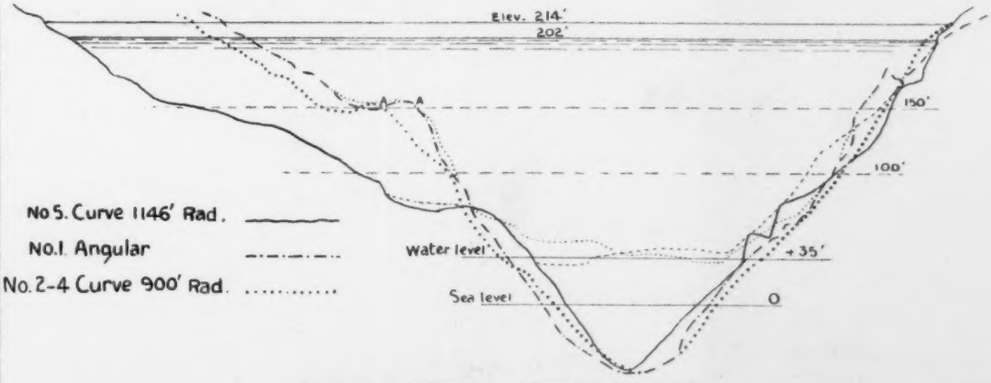


Topographical Map of the Site of Quaker Bridge Dam, across the Croton River, with Ground-Plans of Dam 1, as originally proposed by the Aqueduct Commission Engineers; Dam 5, recommended by the Board of Experts; and (by Dotted Lines) Dam 2-4.

Reduced photographically from the original map on a scale of 100 ft. = 1 in.
Surface Contours shown by solid lines at 5 ft. intervals, every fifth line heavier.
Underlying Rock Contours shown by dotted lines, at 10 ft. intervals, every fifth line heavier.

[The dotted ground-plans for Dams 1 and 5 have been added by us to this map by direct transfer from separate ground-plans of the same scale as the maps which accompany the Report of the Board. The dotted ground-plan 2-4 has been constructed by us of the same radius as No. 2, but on a location approximately more nearly to that of No. 4. The ground plan for it was constructed mechanically from that of No. 1 by laying off radially distances intersecting each contour at the same distance from the face as No. 1].

The earthy material overlying the rock is in the nature of hard-pan, filled with large boulders.



Longitudinal Profiles of Dams 1, 2-4 and 5.

Profiles of Dams 1 and 5 reproduced from the separate profiles accompanying the Report. Profile of Dam 2-4 constructed from the contour map.

The profile is taken on the face line; consequently the distance across the valley of Dams 5 and 2-4 is somewhat exaggerated by 8 to 10 per cent.

gistration undoubtedly cut it down by several thousands. Neither is there the least suspicion of any appreciable amount of fraudulent registration. In the lower ten wards of the city, again, the registration is very moderate, having increased from 90,401 to 95,117, or at the rate of 12.8 per cent. per decade. This compares very reasonably with the figures that we gave in our issue of May 12, 1888, for the growth of population by wards in the 1870-80 decade, as follows:

Wards.	Population. 1880	Incr. p. c. 1870-80
1 to 6	81,541	1.7
7	44,818	11.7
8	34,818	2.8
9	47,609	14.7
10	41,431	14.8
Average 1870-80, about		7.8
" 1884-88, at decennial rate		12.8

This is hardly more than a natural reflex effect of the stimulus which the elevated roads gave to the growth of the city, although their direct effect is to help people to get away from the lower wards. It is these reflex effects which are never considered by those foolish people who reason that what helps one city will hurt another, and *vice versa*.

THE news as to the Panama Canal chronicled in our news columns, is highly significant of the desperate status of that enterprise. Ordinarily, reckless mistatements of possibilities such as LESSEPS keeps giving out, would alone suffice to discredit an enterprise, but DE LESSEPS has shown such carelessness in his prophecies that the world expects absurd statements from him whatever the status of the project, and they neither add to nor detract from the confidence or suspicion which other facts seem to warrant.

In the meantime, the latest direct news from Panama comes from Gen. VICTOR VIFQUAIN, U. S. Consul at Colon, now in this country who says:

"DE LESSEPS thinks the canal will be finished in 1890, but if it is accomplished by 1900 he will be doing well. He is short of money at present and work is at a standstill. In the language of experts sent out by the stockholders 'there is one cent of work shown for every dollar expended.' DE LESSEPS has been popular among the *bourgeois* and they have given him their savings, but their confidence seems to have become exhausted. DE LESSEPS by making a bluff, tried to scare off the Nicaraguan scheme and attempted to get possession of islands off the Musquito coast. The United States Government sent the ship Boston there, but there was nothing moving on the islands upon her arrival. The questions arising from the dispute are still in course of arbitration before the Queen of Spain."

WE are again compelled by thepressure on our space to postpone the continuation of our articles on the Canadian Pacific Railway.

Some Strange Errors of Fact.

We reproduce in this issue nearly the full text of the report presented Oct. 25, by the Board of Experts appointed to consider and report upon plans for the Quaker Bridge dam, with all the illustrations required to make it intelligible. It is in the main an excellent report, with which we fully agree. It has reconstructed the highly objectionable, and in fact indefensible profile which was first proposed for the dam, and which we have repeatedly objected to in our issues of January and subsequently, into a section which is at once symmetrical to the eye, and really strong and durable. It also puts a quietus on the exaggerated claims advanced in the original reports on this subject to the effect that "the strength, economy and safety of a straight dam *far* exceeded what was obtainable by the curved form" and that "there was no valid reason for risking the serious and complicated rupturing strains which a curved dam will produce, nor for the increased expense it will entail." We showed in issues of Feb. 4, 25 and March 3, that instead of the curved dam being "far "the most costly, it was not more costly at all, and instead of the straight dam being "stronger and safer", the curved dam had a certain advantage in this respect for every point of view.

That this view is substantially correct is shown by the estimate accompanying the report of the Board of Experts which appears in another column. That it is not shown to be correct to the letter, in each and every respect, is due only to two facts, one of which only we propose to discuss now, viz., that these comparative estimates are numerically incorrect, containing as they do a number of errors of magnitude which, by a singular coincidence, all tend, when of any importance, either to cheapen the dam originally proposed by the engineers of the Aqueduct Commission, or to magnify the cost of all the other alternatives, we cannot now undertake to say which, but we shall present unmistakable evidence—which we must confess it amazes us that it should have been left for us to discover—that one or the other is true.

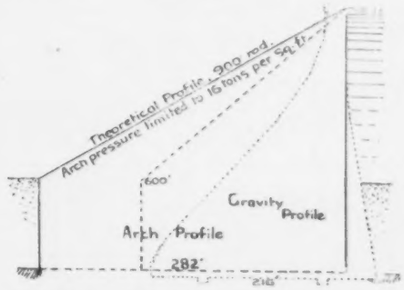
The other cause for the small remaining difference between the Board of Experts' conclusions and our own lies in certain theoretical considerations which we think we can show next week to the satisfaction of every member of that Board, as well as of engineers generally, did not receive from them the consideration to which they were entitled; but for the present we confine ourselves wholly to the question of fact in regard to the comparative estimates which accompany their report, and for which we should state at once that the Board themselves are not responsible. They state explicitly in their report:

"In the study of practicable locations we have been aided by the very thorough topographical maps and records of borings furnished us by your engineer, and have had estimates of quantities made on several locations. The estimate of quantities on these locations have been made by your engineers from the topographical maps and records of borings. They are approximate only, but *being made on precisely the same basis* (italics ours) afford, we believe, sufficiently accurate comparison of the relative amount of work required."

We desire also to state explicitly that, while such facts as we are about to give will necessarily and properly be regarded as having an ugly look; for they have an ugly look, and must, from any point of view, be regarded as anything but creditable to the office in which they originated, yet we do not charge and cannot believe that these errors were deliberate on the part of any one, but rather are the result of bias, unchecked by a sense of fairness, on the part of some member or members of the staff. To suppose them purely the result of accident, surpasses our credulity.

That there has been a tendency to such bias is unfortunately clear from the records, which we may briefly review. The plan first prepared for the dam was that marked X in the accompanying cuts, prepared (chiefly) by Col. JULIUS W. ADAMS, of the Board of Public Works. It was for a straight dam. The engineers of the Aqueduct Commission modified this into Plan Y herewith, likewise straight, which was presented to the Commission for approval. Mr. O. W. BARNES, then a Commissioner, and an old and experienced railroad engineer, objected to the straight dam and proposed a curved one instead, advocating it with much earnestness. The question was referred back to the Aqueduct engineers for report, and the result was the elaborate monograph published in full in our issue of Jan. 14-21 which was intended and was supposed to finally settle the matter.

At this point this journal gave its first consideration to the matter. We had not then, nor have we since, had any conversation or correspondence with Mr. BARNES or with any other person in regard to the merits or demerits of the curved or any other plan, beyond casual recent conversations. We had not, in fact, given the matter any thought or attention, and began the republication of the report with the sole idea that it was probably a final and exhaustive summary of the theory of high masonry dams. It happened, however, that we read the report, (which editors do not always do), in order to editorially summarize its conclusions; and we were then at once struck by the apparent exaggeration of such statements as we have quoted above, and of such comparisons as that in the accompanying engraving, for example, which we again reproduce from the report, in which any engineer can see that the two sections compared



Reduced copy (with line marked 600 added) of "Comparison of Gravity Profile of Quaker Bridge Dam with Theoretical Profile of an arched Dam" from Report of Chief Engineer, ENGINEERING NEWS, Jan. 14.
(Reproduced from ENGINEERING NEWS of March 4).

as equal in stability are really most unequal, the larger one having in fact 6 or 8 times the ultimate stability of the smaller one.

This led us to examine into the whole question for ourselves, and on Feb. 4 and 25 and March 3 we published our discussion of the question, dissenting from the views of the report, not claiming that either plan was "far" superior to the other, but pointing out in detail that the curved faced dam was equal to the other in every respect and superior to it in many respects.

As a consequence, a resolution of the Aqueduct Commission was passed March 7, appointing the Board of Experts whose report appears in this issue to report on the whole question.

By a somewhat similar accident to that which led us first to discuss the matter at all—an apparent great exaggeration—we have been led to examine into the comparative estimates of cost which appear in this new report. To aid our readers in readily understanding the situation, we have combined with the topographical map which appears in this issue—reduced to one-third of the original scale of 100 ft. per in.—the ground plans of dams 1 and 5, which are given separately in the report, but to the same scale. Moreover, the curved dams 2 and 4 being too close together to show separate ground plans for them, we have added by dotted lines a single new location which we call 2-4, having the radius of plans 2, and a location which about averages 2, and 4, appearing to us slightly more favorable than either. The longitudinal profiles of plans 1 and 5, also, we have superimposed on each other and have constructed a similar profile for plan 2-4 from the contour map, first reconstructing profiles for 1 and 5 from the map and finding that they checked almost exactly with those of the report.

Now it is immediately obvious from the map that these ground-plans have about the same area. They have in fact. Measured by the planimeter on the original map they showed

	Area in sq. ins.	Ratio of Area
No. 1 Original Aqueduct plan	152,900	100.0
No. 2-4 Modified Barnes "	154,200	100.85
No. 5 Board of Experts "	165,900	108.5

It is likewise immediately obvious that, inasmuch as the only rock excavation required is to trim off the loose top of the bed-rock, the precise amount of which cannot possibly be foreseen with any exactness for any dam, and inasmuch as the surface indications of the rock are identical for all the sites, which are all close together, and some on each side of the originally proposed site, the rock excavation estimated should be about in proportion to area. Turning to the estimates, however, we found that the foundation work stood as follows compared with this assumption, the average rock trimming allowed for dam No. 1 appearing to be about 7 ft., and for all the others, 1 below and 3 above, 10 to 11 ft.

Rock Excavation, at $2 per cu. yd.

Plan No.	Estimated Cost		Proper Proportionate Cost			Approx. Excess	
	Amt.	Ratio	Area of Base sq. ft.	ratio	pr portionate cost	Amt.	p.c.
1	$81,342	100.0	152,900	100.0	$81,342		
2-4	121,752	149.6	154,200	100.85	82,033	$39,719	48.4
5	127,406	155.4	165,900	108.5	88,256	39,120	48.2
3	117,876	145.50	The same or a little less than No. 1.		81,000 ±	36,876	45.6

Note.—The estimates quoted for No. 2-4 in this and the following tables are those for No. 2. No. 4 differs slightly but unimportantly therefrom. *About 5 per cent. of this difference in the case of dam 2-4 may be accounted for by difference in thickness of the dam, but this correction is neglected because of neglecting a much larger one in the opposite direction, as stated in the text.*

It was this contrast, obviously a wrong and unfair one, which suggested to us to check the entire estimate for dams 1, 2-4 and 5.

Here we were confronted by the fact the Board of Experts had so far dissented from our previously expressed views as to allow that the base of the dam should be made longer if the face be curved, to allow for its shorter length relatively to its face. We shall, as stated in a following issue, show reasons which we think have been overlooked why this correction is an improper one, quite independent of possible arch action, and should rather be in the other direction by a still larger amount; but to merely check the estimate we must take the respective cross-section profiles as they were reported, as follows:

Plan No.	Thickness in feet at + 214	at + 35	at—32	Area sq. ft.
1	20.0	128.2	224.0	26,500
2-4	20.0	135.2	239.5	27,873
5	20.0	133.2	235.5	27,481
	RATIOS			
1	100.0	100.0	100.0	100.0
2-4	100.0	105.5	106.7	105.1
5	100.0	103.9	104.2	103.7

In order to allow in the simplest way for this difference, and also for any possible errors against plan 1, the estimates for which we challenge as too small in proportion, we determined to compare the dams on the basis of respective *square feet of face area.* The average thickness of the curved dams below +35 being some 180 ft., this operates as a loading of about $\frac{\text{half av. thickness}}{\text{radius}} = \frac{90}{900} =$ 10 per cent. against the 900 ft. radius dam, and $\frac{90}{1146} = 7.9$ against the 1146 ft. radius dam, for evident geometrical reasons, since the back face of the curved dam is much smaller than the front, whereas the reverse is the case with the straight dam. This ensures that our computations of error shall at least not err by excess, which is all the exactitude we desire.

Considering first the earth excavation, it should at least be as base × area of cross-section. Really it should be made more favorable to the curved dams, because apart from the reason just noted, the great mass in the slopes would vary nearly as the square of the heights, which average least for the curved dams. Neglecting both these errors on the one hand, and on the other hand difference in thickness, we have the following comparison:

Earth Excavation at $1 per cu. yd.

Plan No.	Estimated Cost.		Proper proportionate cost. Actual ratio of. Bases	Sec. ar.	Ar. × li.	Proportionate cost.	Approx. Excess. Am'nt. estimated.	p.c.
	Am'nt.	R'io.						
1	$268,000	100.0	100.0	100.0	100.0	$268,000		
2-4	318,000	118.7	100.85	96.2	97.0	259,960	$58,040	22.3
5	227,188	84.9	108.5	77.8	84.4	226,192	996	0.4

This computation was made from the following areas:

Plan No.	Sq. ft below +35.	Ratio.	Sq.ft.exc.ab've + 35.	Total.	Ratio.	Adopted ratio.
1	25,380	100.0	5,525	31,075	100.0	100.0
2-4	24,780	97.6	4,700	29,375	94.5	96.2
5	19,380	76.3	6,050	25,500	82.0	77.8

This shows an excess of 22.3 per cent. against plan 2-4 although it checks closely on plan 5. It is apparent at once from the comparative profiles, which we have redrawn to common base lines, that plan 2-4 cannot have 18.7 or any other per cent. of earth stripping to rock. It appears from the above to have 3 per cent. less, making a second excess of some $58,040 to be added to the $39,719 above.

Imaginary excavation necessarily requires imaginary masonry to fill it up, either in a dam or an aqueduct tunnel, so that the disadvantage works both ways. We have for the masonry below the river level, or + 35 above sea-level, the following comparison:

Masonry below + 35, at $6 per cu. yd.

Plan No.	Estimated cost. Amo'nt.	R'tio	Proper proportionate cost. Area sq. ft.	Area ratio	Proportionate cost.	Approx. Excess. Am'nt.	p.c.
1	$1,072,226	100.0	25,380	100.0	$1,072,226		
2-4	1,277,716	118.5	24,780	97.6	1,046,493	224,223	21.4
5	908,754	84.8	19,380	76.3	818,108	90,646	11.3

The areas given are the respective *face* areas as noted in the text.

In all, then, below the river level, + 35, we have an excess of $321,982 over the proper comparative total of $1,388,486, an average excess of 23.2 per cent.

Continuing these computations we find the following results, the estimate agreeing much more closely with our figures, as was to be expected, but nearly always with an apparent leaning in one direction. This leaning, standing by itself, we should not have thought of questioning, but should ascribe to some chance error, but coming, as it does, in connection with the much larger and unmistakable errors above noted, and in spite of a method (comparing by front face areas) which leans heavily in favor of the straight dam anyway, and which we have adopted for that reason, we cannot but feel that, with possible single exceptions, all the figures given under-state rather than over-state the real contrast, as it is certainly our purpose that they should. We have no time to go into precise computations, and our one-sided method of comparison—purposely selected as being so, so that we might by no chance over-state—makes it absurd to seek any greater precision than the slide rule gives, which may err one or two tenths of one per cent., or to do more than rudely compute the areas by two to five different ways, which agreed within about half of one per cent.

Masonry from River Level (+ 35) to Top.

Plan No.	Estimated Cost. Amount.	Ratio.	Proper Proportionate Cost. Area sq. ft.	Ratio.	Amount.	Approximate Excess. Amount.	p. c.
Masonry between + 35 and + 100 at $6.60 per cu. yd.							
1	$1,072,850	100.0	40,950	100.0	1,072,850		
2-4	1,082,129	100.9	42,770	104 4	1,120,055	—$37,926	—3.4
5	1,008,08	99.4	39,325	96.0	1,029,936	8,149	3.7
Masonry between + 100 and + 150 at $7 per cu. yd.							
1	$592,494	100.0	40,775	100.0	$592.494		
2-4	656,3?7	110-8	44,675	109.6	649.376	$7,021	1·0
5	899,213	151.7	55,250	135.5	802,829,	96.384	14·9
Masonry between + 150 and top at + 214 at $8 per cu. yd.							
1	$695,952	100.0	78,303	100.0	$695,952		
2 4	767 976	110·4	82.645	105.5	734.228	$33.748	4.6
5	889,944	127·9	100.733	128.6	891,994	— 5.050	—0.6
Masonry coping at $30 per lin. ft.							
1	1403	$42.090	100.0	1470	100.0	$42.090		
2-4	1496	44 880	1·6.6	1509	102·0	42,932	$1.948	4.5
5	1693	50,790	120.6	1715	116.7	49.119	1,671	3.4

Summarizing, we obtain the following comparative aggregates, the first column giving the amount estimated for each item; the second column, the amount as we have computed above that it should be to be in no greater proportion to the corresponding amount for the straight dam than the ratio of the longest curved face of the curved dams to the shortest straight face of the straight dam, being an allowance in favor of the straight dam of 6 to 9 per cent. The third column gives the excess in dollars, and the fourth column gives the excess per cent.

SUMMARY.

Plan 2-4.	Estim'td Cost.	Computed Cost.	Excess of Est'd Cost.	Excess p. c.
Earth Excavation,	$318,000	$259,960	$58,040	22·3
Rock "	121.752	82,033	39.719	48.4
Masonry below +35	1,270,716	1 046 493	224.323	21·4
" + 35 to + 100	1 082,129	1.120,055	(—37 226)	(—3.4)
" + 100 to + 150	656,397	649,376	7,021	1.0
" + 150 to + 214	767,916	734,228	33 748	4.6
" coping.	44 880	42 932	1,948	4·5
Totals,	$4.261,850	$3,936,077	$326 773	8·3
PLAN 5.				
Earth Excavation,	$227,188	226,192	$ 996	0.4
Rock "	127,406	8?.56	39,15	48·2
Masonry below +35	908,754	818,108	90,646	11·3
" + 35 to + 100	1.068,085	1,029 936	38,149	3.7
" + 100 to + 150	899,213	802,8.9	96.384	14·9
" + 150 to + 214	889.944	894.994	(—5,050	(—0.6)
" coping.	50 790	49,119	1,671	3·4
Totals,	$4.171.380	$3,909,434	$261,946	6 7

The amount and per cent. of excess in this table should be at least doubled if the areas were taken on a cylinder (i. e., curved plane) through the center of mass instead of on the larger front face, increasing the per cent. to say 16.6 and 13.4. On the other hand they should be decreased by about 5.1 and 3.7 per cent. respectively to allow for the different thickness recommended by the Board of Experts, leaving 11.5 and 9.7 per cent. excess, instead of 8.3 and 6.7 above. To allow for possible errors of computation these corrections have both been neglected.

Therefore, instead of the cost of these dams standing to each other in this ratio:

	Amount	Excess	Ratio
1.	$3,824,754	——	100.0
2-4.	$ 4,261,850	$437,096	111.4
	4,286,044	461,290	112.1
5.	4,171,380	346,626	109.1

They should by the face of the above figures stand in this ratio:

1.	$3,824.754	——	100.0
2-4.	3,935,077	$110,323	102.9
5.	3,909,434	84,680	102.2

Were the error deliberately made in favor of No. 1 corrected, they should stand considerably cheaper than No. 1. *Per contra*:

Were the error to allow, or the difference in thickness recommended by the Board of Exports also corrected, the curved dams should still stand considerably cheaper than No. 1 but by a less amount. We think we shall have no difficulty in showing next week, when we discuss the theoretical side of the question in a succeeding issue, that such allowance was improper.

Finally, we think we shall have no difficulty in showing next week that to compare the

dams on a basis of equal strength, quite apart from any possible arch action, the transverse section of the arched dams may be made thinner instead of thicker, by a very considerable percentage.

In the meantime, we have only to say that errors of fact in estimates of this character should not occur.

The Two Nicaragua Ship Canals.

Just now the President of the American Atlantic & Pacific Ship Canal Co. is in London, with the modest request that English capitalists advance his company the sum of $100,000,000 on "first mortgage gold bonds, running 50 years at 6 per cent." These bonds are to be secured by a mortgage deed on the ship canal, railway and other properties, and the promise is made that if the money is subscribed, they will go to work at once and complete the canal in three years—"if not prevented by prejudicial action of the Government." Just how important this particular "if" is in its bearing on the case, can be learned from a brief review of the history of the Atlantic & Pacific Ship Canal Co. In 1849 it did obtain a *bona fide* concession from the Nicaragua Government of the "exclusive right and privilege of constructing a ship canal across its territory by a single route," that is by way of the San Juan river and Lake Nicaragua. In 1850 the company was incorporated under the laws of the Republic and the noted CLAYTON-BULWER treaty was negotiated with special reference to its needs. In 1851 the Accessory Transit Company was formed, separating the transit powers from other rights of the company; but this latter company was also owned wholly by canal shareholders. In 1856 Nicaragua confiscated all the property of the Transit Co. and annulled the canal concession. The following year the contract was re-established, only to be annulled and again reenacted in 1859, 1860, 1862 and 1863. Again in 1868 the property of the Transit Co. was seized, and the Nicaragua Government of course held the concession to be withdrawn. The Atlantic Co. does not admit this withdrawal, and defends its position in a bulky pamphlet; but the authorities of Nicaragua say it is withdrawn, and that any claims based on an older action are illegal and void. Nicaragua is a Government, with full powers as such, and as the London *Financial News* truly says in commenting on this matter, no court can force it to recognize a series of contracts which it now disavows. Practically then the bonds offered to British investors are based solely upon no concession at all, or at the best a disputed concession. Bad as are the present prospects of the Panama shareholders, their paper is gilt-edged compared with what these new canal promoters have to offer.

The *Financial News*, which takes a thoroughly neutral stand between the Atlantic & Pacific Co. and its later rival, the Nicaragua Canal Association, says that this canal enterprise is so essentially American that the official sanction of the U. S. Government is absolutely necessary before either project can be successfully launched in financial circles, and the company that gets this sanction first will take the lead in the work. This is true to a great extent, and it is well in this connection to review the work done by the Nicaragua Canal Association and the claim it clearly has for asking of our Government this recognition, which is all it asks.

The Nicaragua Canal Association went about its work with business-like methods, with the evident honest intent to build a ship canal. It first obtained a concession that is fully recognized by the only Government that had a right to grant this concession, and the commenced to carefully collect all the data essential to a reliable estimate of the cost of the canal, after the best possible route through Nicaraguan territory had been fixed upon. Its surveys have been elaborate and exhaustive, and the results obtained have exceeded even the most sanguine hopes in location and cost of execution; and this company can now truly say that it alone possesses the material necessary as the basis of any intelligent estimate of the true magnitude of such an undertaking. Any other schemes are merely projects in the air, without basis other than such as erratic fancy may suggest to meet the wants and purposes of the hour. This canal across Central America is "essentially American" and is most important to American commerce present and future—for it will be a potent factor in building up a merchant and a war marine, and as the U. S. Senate has already passed its American charter, the House should lose no time when it comes together again in doing likewise. A canal will connect the two oceans on this route sometime; and when it does the United States must either control it to commence with, or get into trouble in striving to prevent some other nation from picking up the chance which it has carelessly cast aside.

Our Government should recognize the canal company having undisputed national rights and the one that is the best equipped to carry this enterprise to a successful end. The claims to this right of the one company have already been considered; those of the Atlantic & Pacific Co. will hardly bear stating. This latter company had the sanction of our Government and had concessions from Nicaragua nearly 40 years ago; but either because the times were not ripe for such a canal, or by mismanagement and general inactivity, they have long ago forfeited the official recognition of this Government and are now denied all rights by Nicaragua. In fact, they have no rights, no surveys of note, and no definite plan of action, other than to sufficiently re-galvanize into life a very defunct scheme to make it the object of "a deal" with more progressive corporations.

PERSONAL.

CHARLES W. IRISH has had his appointment as Surveyor-General of Nevada confirmed by the Senate.

Col. JULIUS W. ADAMS, Ex-President of the American Society of Civil Engineers, has been elected an Honorary Member of the Society.

Prof. HENRY C. ADAMS, of Michigan University, has been appointed statistician to the Interstate Commerce Commission.

W. W. CUNNINGHAM, Superintendent of the water-works at Huntington, W. Va., has accepted a similar position at Clinton, Ill. He will be succeeded by JOHN NORRIS.

R. H. SOULE, formerly Superintendent of Motive Power and General Manager of the N. Y., L. E. & W. R. R., has been appointed General Agent of the Union Switch & Signal Co., and is, among other duties, to have charge of the sale and introduction of the Westinghouse buffer just introduced.

HENRY A. GRAY, C. E., formerly attached to the Public Works Department, Ottawa, as Assistant Chief Engineer, has been recently appointed Engineer-in-Charge of the Maritime Provinces, one of the most important offices in the Department of Public Works. His headquarters are at St. John, New Brunswick.

PHILIP R. GEORGE, for 40 years manager of the mining interests of Cooper, Hewitt & Co., died at Ringwood, N. J., Oct. 22. He was considered one of the best authorities on practical mining in the United States, and was employed as an expert in the Tilly Foster mining case, and by his testimony saved the city of New York several hundred thousand dollars.

J. B. CHAPIN, Assistant Division Superintendent of the Boston & Albany, has resigned his position. He had been with the company for 47 years, coming into its employ 2 years after the road was built, and served 41 years on the Albany division, 19 years as conductor and 22 years as Assistant Division Superintendent. He will be succeeded by S. H. CLARK.

WM. E. FITCH, General Manager of the Fremont, Elkhorn & Missouri Valley and Sioux City & Pacific railways, with headquarters at Omaha, Neb., has resigned to accept the position of General Manager of the Duluth, South Shore & Atlantic, with headquarters at Marquette Mich. He will be succeeded on the other roads by HORACE G. BURT, now Chief Engineer of the Chicago & Northwestern.

Irrigation in the Arid Regions of the United States.

An answer to some of the wild hopes regarding irrigation in the arid regions west of the Mississipi, and an answer also to the wilder mistatements regarding the feasibility of the project, is found in the letter of Maj. J. A. POWELL, Director of the Geological Survey, to Secretary VILAS.

Maj. POWELL says that the area of the arid region is about 1,300,000 sq. miles, and that 1,000,000 sq. les of this only need water to make it productive. At $30 per acre, a moderate estimate for irrigated land, this area would represent the enormous aggregate value of $19,200,000,000. Over this region the annual precipitation ranges from 5 ins. or less, on the dryest plains, to 30 ins. on the mountains, with an average for the whole region of about 15 ins. If this could all be applied to the land, there would be about double the amount required during the growing season.

But unfortunately many causes conspire to render impossible the full realization of so desirable a result. Of the precipitation which has the form of snow, a large fraction is returned to the air by evaporation without going through the process of melting. Of that which falls as rain, a large part is received by the soil and evaporated from it without gathering in streams, and the only portion of such unconcentrated rainfall serviceable for agriculture is that which falls on the farming land during the growing season. Of the water from rain, and melted snow which gathers in channels and forms streams, only a portion has such relation to arable land that it can be utilized; the remainder flows too low or at such distance from the land as to be beyond the economic limits of conveyance. Moreover, a comparatively small portion of the stream water is furnished during the farming season, and that which must be stored in reservoirs in order to utilize it, necessarily suffers material loss by evaporation.

Under such adverse conditions it is manifest that only a small portion of the rainfall of the region can be made to serve the farmer, and that there is no solid foundation for the opinion sometimes expressed that the greater part of our arid west will ultimately be reclaimed. In 1880 less than 1 per cent. of its arable portion had been supplied with irrigation water, and it is not believed that with the most elaborate irrigation works this can be increased to more than 20 per cent. On the other hand, an estimate based on such data as are available, leads to the anticipation that when all the larger streams have been brought under control, and the storage of water has been carried as far as it may be economically, there will be redeemed about 15 per cent. of the region, or 150,000 sq. miles, the whole comprehending an area which exceeds one-half of the land now cultivated in the United States. At $30 per acre, this will add $2,880,000,000 to the wealth of the nation.

But the 15 per cent. that Major POWELL modestly estimates as capable of improvement by irrigation, while it is now valueless, exceeds by about 20,000 sq. miles the combined area of England, Scotland, Ireland and Wales, and is well worth adding to the revenue producing territory of this country. What it will cost to make this land fertile is another question, that cannot be solved until the appropriation for this purpose is in hand and careful preliminar surveys and estimates made. But it is evident from the above figures that an enormous sum can be expended for these improvements and still leave an exceedingly handsome margin of ultimate profit.

THE first train passed through the Wickes tunnel, of the Montana Central R. R., on Oct. 25. This tunnel is 6,200 ft. long, runs through a mountain of the Boulder divide, 18 miles from Helena, Montana, and cost about $1,500,000. It was commenced in May, 1887; and was "holed" in September of this year. The tunnel will be lined with masonry at a further cost of about $250,000.

The Walnut Grove Dam.

In our issues of Sept. 22, and Oct. 20, were descriptions of the Walnut Grove Dam in Arizona, the latter paper illustrated. In the last number of the transactions of the Technical Society of the Pacific Coast, we find some notes on this same structure by Mr. LUTHER WAGONER, from which we extract the following further details:—

The Walnut Grove dam is situated on Hassayampa creek, about 35 miles south of Prescott, Arizona, and lies at an elevation of about 3,500 ft. above sea level. The drainage area above the dam is 390 sq. miles, and the average annual rainfall is assumed at 16 ins. The country rock at the dam is a coarse-grained granite, easily quarried.

Work was commenced by the New York company under plans of Prof. W. P. BLAKE, who carried a wall across the cañon through about 20 ft. of sand and gravel. He was succeeded by Col. E. N. ROBINSON, and the dam was built of quarried granite, as previously described in this journal, under contract with NAGLE & LEONARD, of San Francisco.

In Mr. WAGONER'S paper the inlet tower is more fully described than in our previous articles. This tower was built of 8×8 in. timbers 8 ft. long, notched one half at each end, secured by a ⅝ in. iron bolt through each corner, and the joints caulked with oakum and the outside painted with paraffine paint. There are two inlet valves, one at the base of the tower and one 20 ft. higher. The gates were of wood, sliding on wood, with about 15 sq. ft. under pressure. A 6-in. square wooden stem runs up on the outside of the tower and above the platform on the tower where the mechanism is placed to operate these gates. This mechanism was arranged as follows: The square valve stem had a rack on one side and a plate of iron on the other; a roller acted against the plate to keep the stem in position, and a pinion engaged in the rack and in a large spur wheel placed between it and another motor pinion. All of this was mounted on a heavy iron bed-plate resting on a frame on the platform. This machine did not work very well, according to Mr. WAGONER. Two men working on the motor pinion could exert a pull of about 700 lbs. on the valve-stem. But with 30 ft. of water pressure the valve could not be moved, for the good reason that the load to be overcome was over 11,000 lbs. This gear was erected under protest, and the reason assigned for its adoption was that it was "designed by an engineer and must work."

The contract price for the dam proper, 46,000 cu. yds., was $2.40 per cu. yd., with the wooden sheathing and cementing extra. The lumber cost about $15.00 per M. at the dam, and $2,000 freight was paid on $1,000 worth of cement purchased in San Francisco.

A New Girder for Supporting Cement Walks and Floors.

Mr. JOHN MCGILLIVRAY, of Sacramento, Cal., describes in *The Bee* of that city a late invention of his own for a girder to support patent stone pavements or floors in buildings. He claims tightness, durability and cheapness. His patent may be described as follows:—

The girders are of iron, the cross section being in the form of a hollow triangle with projecting flanges at the two lower corners. These girders, for a sidewalk on a business street, can be supported on piers, or as is more usual, one end placed on the bulkhead and the other let into the foundation of the building. The girders are set about 3 ft. 8 ins. apart and pieces of 1 or 2-in. stuff rest on the flanges and afford temporary support to the cement while setting. Once set, the slanting sides of the girders give the necessary support to the artificial stone, and the wood can be removed if desired. For making floors in fire proofs building the wood is bolted on the bottom of the girders and gives a basis for plastering the room below. For work of this kind, heretofore it has been necessary to have ⊥ girders with brick or iron arches resting on the cross piece of the ⊥; and on these arches, after leveling with sand, was laid the cement. This made a very heavy and expensive floor or walk, and, in case of large buildings, floors of this kind not only weakened the structure by their weight, but the arches, unless elaborately bolted together, have a tendency to spread the walls. MR. MCGILLIVRAY'S patent, it is readily seen, does away with all these objections. Several walks in Sacramento have already been laid with these new girders.

A Railway Dust Abater.

A device which seems to be worth a trial has been patented by Mr. EDMOND REDMOND, of Rochester, N. Y., to reduce the dust caused by the passage of trains. It is based on the fact that the wheels of a car or locomotive, by their rotation, act as fans to disturb the dust on the road bed and throw it up around the train. The theory is that by preventing the wheels from throwing off a current of air, the dust on the track will not rise so much. In the words of the inventor.

"At thirty miles an hour, the average sized railroad car wheel revolves 6 times in a second, and generates a whirling motion of the air around it that is virtually a miniature cyclone having a horizontal axis. The brackets on the inside of a wheel act like the leaves of a fan to throw off the air in a whirlwind. As the top of the wheel moves quickest, the dust is projected upward by centrifugal force, causing friction on the axles, dirt in the upholstery of the coaches and discomfort to passengers."

The appliance consists merely of a set of stationary guards or leaves of sheet iron, set around the car wheel at intervals, either horizontally, vertically or radially, their plane being perpendicular to the wheel, so as to prevent the current of air from the wheel either striking down on the road bed in front, to disturb the dust, or up behind to carry the dust with it. The leaves of the guard are made to conform to the section of the wheel and are set close to it. They are attached to the car truck by a frame or rods, and when once fixed in position need no further care. For the prevention of the most injurious form of dust, iron particles, it is suggested that the leaves can be magnetized, and will then catch all the particles of iron arising from the friction of the wheels and rails.

We should imagine that the device would have more or less of the effect desired, to check the formation of dust although much dust would still rise on dusty roads. It would certainly tend to retain iron particles and thus be of use on elevated lines.

ENGINEERING NEWS.

THE Thames River Bridge, at New London, Conn., according to the Providence *Journal*, is approaching completion, and it is hoped that the two deck spans, between the west abutment and Pier No. 1, and between Pier No. 5 and the east abutment, will be in place this winter. As we have before mentioned, these piers are founded on timber cribs settled 20 ft. into the mud, and then on piles driven in the pockets, sawed off and used as the basis of open caissons carrying the pier masonry. The *Journal* notes the fact that the pile-heads when sawn off did not rise to the surface as expected. The engineers explain this by the vibrations from 200 to 300 blows on each pile, in driving it 50 ft. under water, so affecting the fiber as to expel the air and replace it by water, rushing in to fill the vacuum created.

BRIG. Gen. RUGER, Col. W. P. CRAIGHILL and Col. B. HODGES are the members of the court of inquiry into the frauds of the Washington Aqueduct tunnel, and are now in session in Washington. All kinds of reports are before them, from engineers, inspectors, bricklayers and contractors. Lieut. THOMPSON, the engineer in charge, reports that the brickwork is invariably good, but that the backing is in some places "criminally bad;" voids 6 ft. high and 12 ft. long have been found. The court has personally inspected some of the bad work.

THE Connecticut River Improvement Association has been organized by prominent manufacturers of Springfield, Holyoke, and Chicopee, Mass., for the purpose of inducing Congress to take action for the improvement of the Connecticut river navigation as recommended by a Board of United States Engineers. The work will include a canal from Enfield to East Hartford, about 15 miles, and a considerable amount of dredging at different points on the river. It is stated in the report of the Chief of Engineers for 1887, that the improvements in the river below Hartford reduced freight charges 70 cents per ton, and that the receipts and shipments for 1886 amounted to over 995,000 tons, worth nearly $65,000,000. The proposed improvements are not difficult or expensive, considering the great benefits to be derived therefrom, and all preliminary surveys, maps and estimates have already been made.

M. DE LESSEPS is still zealously engaged stumping the country for the purpose of forming committees to procure subscriptions for the unsold Panama Canal lottery bonds, but he does not meet with very encouraging success. Three hundred local committees are engaged in the work, but the Central Committee, abandoning hope of disposing of all the 1,200,000 unsold bonds, now announces that subscriptions "will be considered definitive" if only 200,000 of the bonds are sold. The company has likewise reduced the price of the bonds 10 fr. Silence is maintained regarding the disposal of the remaining million of the bonds but from the fact that they now only hope to float 200,000 of them at 450 fr. or $18,000,000 worth in all (for they would hardly set a definitive limit lower than the highest total they could reasonably hope for) the chances of the company would seem to be very slim; $18,000,000 will hardly do more than cover floating obligations.

THE CONSUMPTION OF WATER PER DAY in seven of the largest cities of the United States was as given below in response to telegrams sent by B. S. CHURCH, Chief Engineer of the Croton Aqueduct, Oct. 29, 1888, addressed to the Chief Engineers of the several cities; replies give the rate of consumption on Oct. 29, 1888:

	Galls. per cap. per day.
St. Louis	73
Philadelphia	90
Baltimore	100
Cincinnati	107
Washington	145
Buffalo	153
Chicago	160

The above table authoritatively emphasizes the tendency to increase the consumption of water in our large cities, and as New York is likely to use more water than Chicago, rather than less, the necessity is clearly indicated for the acquisition of a larger supply by the immediate building of the Quaker Bridge dam.

SOCIETY PROCEEDINGS.

Engineers' Club of Philadelphia.—Record of business meeting, October 20th, 1888. Past-President FREDERIC GRAFF in the chair; 21 members present. The following were elected Active Members of the club: Messrs. CHAS. H. DAVIS. WM. E. GOOD, JAMES MURRAY AFRICA, E. A. HEBBING, H. KAUFFMAN, Jr., JAMES D. MOFFET, R. TAYLOR, GLEAVES and CHARLES LINDSTROM.

At the last business meeting, on June 16, 1888, the Secretary presented communications from the Engineers' Club of Kansas City, dated May 14, 1888, and from the Western Society of Engineers, dated June 12, 1888, asking the co-operation of the club in efforts to properly regulate, by law and otherwise, the design and inspection of highway bridges. On motion of Mr. HENRY B. SEAMAN a committee of three was appointed, consisting of Messrs. HENRY B. SEAMAN, Chairman, WM. H. BURR and HENRY G. MORSE, to co-operate with the committees of the above-named Societies. This committee reported on Oct. 6, to the following effect.

We will broadly state that, in our opinion, an officer known as "State Engineer" should be appointed in all States where that officer is not found, and that copies of strain sheets of all highway bridges, showing sections, sizes and dimensions, should be deposited and kept on open file in his office, together with such working drawings as will convey to a competent engineer an accurate knowledge of their general design and details. It may be also advisable to deposit a similar set of strain sheets and plans in the office of the county clerk or other proper county official.

We are also of the opinion that the construction and maintenance of highway structures should be constantly subject to the inspection and authoritative supervision of that engineer to such an extent as to insure the proper discharge of the duties of counties, towns and cities, in regard to their highway structures, without in any way relieving them of such responsibilities.

Mr. H. W. SPANGLER presented a paper on Multiple Expansion Engine Cards.

The Secretary presented, for Mr. C. A. SUNDSTROM, a paper upon the Theory of Elastic Curves.

Mr. R. P. SNOWDEN exhibited two specimens of old rails. The small rail is a piece of the first rail used by the Camden & Amboy R. R., weighing about 20 lbs. per yard. The rail was laid on a beveled stringer, and spiked only on the outside of rail. About eight miles of this was laid from Cooper's Creek eastward. It was found unsuitable, causing many accidents. No splice was used, and the ends curled up, making "snake heads," as remembered by some of the older members. It was replaced by English rails, 40 lbs. per yard, of a pattern similar to the old 67 lb. rail of 1873.

The large section is a piece of 7¼-inch rail, laid about 1847, near Bordentown shops, Ernston, and Camden. It was of slightly differing sections, weighing about 90 lbs. to the yard, and was put down as an experiment. It was laid with wooden joints. The experiment was unsuccessful, the height of rail making it impossible to keep it from turning over, even with the wooden brace blocks which were put on soon after the rail was laid.

The Secretary exhibited, for Mr. FRANK H. TAYLOR, a section of hand rail from bridge over railroad, involving the question of the Effects of Gases, etc., from stacks upon iron. In transmitting the specimen Mr. TAYLOR said, under date of October 18, 1888: "I would present a section of a hollow wrought iron hand rail taken from the bridge at Girard and Belmont Aves. this city, over the Penna. R. R., in March, where it had been constantly exposed to the gases from the locomotives. It had been in place since 1875 or 1876, and is interesting as showing how little the section has wasted away from rust." In reply to inquiries from the Secretary, Mr. TAYLOR says, under date of October 20, 1888: "Referring to the sample of hand rail, the original thickness varies slightly, but is never far from 3-32 of an inch, the weight seldom being 4 lbs. per foot. "I cannot say about the amount of painting, but I do not think any paint was ever used inside. Ontside, it has been kept well painted and never allowed to rust until after it was removed from the bridge. The point of interest is that inside, where no paint could be used for a long period of a dozen years, the section wasted so little. When in use, there is a channel under the section sent you—the latter being fastened by a clip about every 18 inches." The metal in specimen exhibited is still full 3-32 inch thick.

The Secretary exhibited specimens of blue prints made on Linaura, a new prepared linen, of apparently excellent quality and almost unlimited durability, showing excellent blue color, very white lines, and white back.

HOWARD MURPHY, *Sec. and Treas.*

[From our own Correspondent.]

(*Concluded from Page 33.*)

American Society of Mechanical Engineers; 18th Meeting, held at Scranton, Pa., Oct. 15 to 19, 1888.—The reports of the various committees followed the proceedings noted in our last issue and then an announcement of the officers elected for the next year, as follows:—President, HENRY R. TOWNE; Vice-Presidents, WM. KENT, THOS. J. BORDEN, and C. B. RICHARDS; Managers, GEO. M. BOND, F. H. BALL and WILLIAM FORSYTH; Treasurer, W. H. WILEY.

This was followed by a most peculiar motion and for a most peculiar reason. It seems that some members, finding themselves unable to attend but one meeting in a year, and cherishing a most envious disposition toward those whose professional engagements permitted them to attend two, proposed to curtail the others' enjoyment by substituting one meeting per annum in future. They persuaded one of the newly elected members to prefer their request, and the presenter excited the sympathy of all present by his endeavors to give a reason for the motion. Of course, he did not want to give the true one, for that showed such innate selfishness as to appall every one, and he cited the fact that the movers were unable frequently to attend two meetings, and seemed to forget that this very argument was a reason for holding two, since these gentlemen would be much more likely to attend *one* meeting if they had two dates to choose from. He also thought the papers would improve if there was but one meeting. Just why this would occur, he failed to state, and was rather emphatically "sat upon" by the meeting. He will learn better next time and won't try to attain distinction by being a cat's paw for older hands.

The following papers were considered: "The Use of Compound Engines for Manufacturing Purposes", by CHAS. T. MAIN, which showed, in the discussion, the comparative advantages of steam and water power, with a decided preference for the former. This was followed by "The Flow of Steam in a Tube" and "A Simple Calorimeter", both by Prof. C. H. PEABODY, of the University of Technology.

In the afternoon the party visited the works of the Lackawanna Coal & Iron Co. These works run back in history to a forge erected in 1799, by EBENEZER SLOCUM and JAS. DUWAIN. They have had various vicissitudes, and in 1840 erected a small blast furnace, two of its projectors being still with the company. In 1842, the first successful blast was made, and in 1845 the first rails were made. In 1847 the first steam engine ran between Carbondale and Wilkesbarre. This was the celebrated engine "Stourbridge Lion", run by HORATIO ALLEN. The rails made here are recognized as of great chemical purity and of uniformity; the management having prided themselves on preserving their standard. The rolling capacity is about 200,000 tons per annum. The plant consists of five furnaces, one Bessemer plant and two steel rolling mills. There were in erection, at the time of this visit, two new sets of blowing engines for the steel department. They attracted considerable attention because they were designed by one of our Members, Mr. W. F. MATTES, and because they impressed the beholder as carefully adapted to do the work proposed for them.

These engines were of the horizontal type, with a 54-in. blowing cylinder and 50-in. steam cylinder, and have a 5-ft. stroke. The grates are provided with a rock bar, and the ash pits have an induced current of air, so as to permit the use of culm. The ore used here is principally American magnetic bessemer, coming from Crain Point, Chateaugay, Tilly Foster and Lake Mahopac. That evening the Society put on its dress suit, if it had one, and attended a reception at the Young Men's Christian Association House.

The first flow of wisdom the next morning came from the past President, Mr. GEO. H. BABCOCK, and was extremely interesting, as his remarks always are. The subject was the "Flow of Steam." The following papers were then considered:

"System of Worm Gearing of Diametral Pitch", by S. W. POWEL and W. L. CHENEY; "An Improved Method of Finding the Diameter of Cone and Step Pulleys", by C. A. SMITH; "Some Tests of the Strength of Cast-Iron", by GAETANO LANZA; "A Foundry Cupola Experience", by FRED. A. SCHEFFLER; and "On the Identification of Dry Steam", by Prof. DENTON. This last paper was supplemented by photographs of steam taken at various distances from an escape cock, which showed varying characteristics and were examined with great interest. Dr. CHAS. E. EMERY followed with a paper on "Cost of Power in Non-Condensing Engines", and was succeeded by Prof. LANZA with a paper entitled "The Counterbalancing of Locomotives". "Topical Discussions", that most important of all subjects, then claimed attention, and much practical information sifted and filtered from the magnates in the profession, varying according to the condition of subject, being either "dry" or "wet." That afternoon excursions were the order of the day. The Pine Brook Coal Breaker, which is one of the largest and best in the region, was inspected and some climbing indulged in. The mine underneath is 170 ft. deep, and is located not far from the center of Scranton. After this the Dixon Manufacturing Works were visited, and some of their beautiful machine tools inspected and admired.

Your correspondent, with several others, visited the refrigerating machine of Messrs. HENDRICKS & SIMPSON, where cold air is furnished by the absorption process for preserving meats. The plant was extremely compact, and in fine working order. At the time of the visit, engineers were making tests to determine its efficiency, every facility being afforded them by the genial and hospitable proprietor. It occurred to the writer that a contract to supply two distinguished statesmen from the East with the necessary refrigeration would be a fortune to Mr. HENDRICKS. From here we went to Col. BOIE'S Car Wheel Works. It may be stated, that here we saw the prettiest and most compact machine shop in the country. The plates and tires for making the wheels are delivered here, and the wheels put together. For convenience of fuel the shop stands at the foot of an immense pile of culm sufficient to last as fuel for many years. The steel plates are put into a hydraulic press, and the hub and a small flange obtained. The hub is cut to a smooth surface inside and out, and the small flange also trimmed to a true face at the same time by a machine having three cutters. The steel tire is put on by heating it, and then applying hydraulic pressure, and the two sides are fastened by bolts. These wheels are guaranteed to run 350,000 miles, and the output is 25 wheels per day. Everyone remarked on the compactness and completeness of this machine shop. It may be said that the tires are for the most part from the manufactory of the Standard Steel Co.

That evening additional papers were read till 9.30. They consisted of "The Overhauling of a Mechanical Power", and "The Mechanics of the Injector", both being by Prof. J. BURKITT WEBB. It was shown in the latter paper that 15-16 of the energy was lost by impact in the injector, and he thus accounted for the small efficiency of it as compared with a steam pump.

That night at 9.30 P. M., the party were invited to take a moonlight ride over the electrical railway. So far as your correspondent was concerned, the invitation was declined with thanks. He had been over that road, and the trip had resulted in a new movement for his watch. This was too expensive a luxury to indulge in freely, and as he did not know any convenient place to leave his chronometer, and not seeing his "uncle's" shop handy, he decided to stay at home. The next day was devoted to an excursion, and it was a most complete success. The party started at 9 A. M. Hawley was reached about eleven, and the silk mills visited. They are run by water power.

Next we went to the cut glass works at White's Mills, where the various processes were shown, always resulting in an empty decanter or wine glass. When the proprietor's attention was called to this, he apologized and gave as an excuse, the *size* of the party, which was even a better reason than he dreamed of, for he only included a count per *capita*, and any calculation based on this idea of size alone, and omitting that of capacity, would have been most terribly erroneous; evidently he had not studied *Dry Measure*. Thence the party went to Honesdale and dined, that is, the Mechanical Engineers did after the invited guests had been served, and all took the gravity cars of the Delaware & Hudson Co. over the Moosic Mountains. The party were in six excursion cars, and were hauled up an incline, three cars being taken at a time. At the summit the six were coupled together and sped away for nine miles till they reached the foot of No. 15, where they were again hauled to a higher elevation and again started off. The speed attained was from 15 to 60 miles per hour and the entire distance run by gravity was stated to be 30 miles. The dangers from cows, crossing teams, etc., will be noted when one considers there is no possible means of giving any warning of the approach of the train. It runs noiselessly, and with great speed, and having no engine possesses neither bell nor whistle. The management point to the fact that they have had no accident for fifteen years, but that brings them just fifteen years nearer to one, according to the theory of probabilities. This ride, and the return to Scranton, completed the excursions of the session. The concluding paper was read by Mr. C. J. H. WOODBURY, on "Electric Welding," and attracted much interest. The samples were exhibited which had been the result of the process, and an animated and commendatory discussion followed. The usual votes of thanks to everyone and everybody were next in order; that they were well deserved goes without saying, we had all enjoyed ourselves to the utmost and our kind hearted entertainers had kept up the reputation for most excellent and unbounded hospitality for which Scranton is so famous. The next morning a number of the party accepted the kind invitation of the Scranton Steel Co. to visit their works, where they saw the finest steel plant in the United States. This was the closing act, and the party separated to meet at Erie, Pa., in the spring of 1889.

Montana Society of Civil Engineers.—A regular meeting was held Oct. 20 at the office of E. H. BECKLER, Chief Engineer of the Montana Central Ry., at Helena. A paper on "The Ingersoll Rock Drill," was read by E. O. GOODRIDGE. A communication from GEO. O. FOSS, relative to the difficulties encountered in endeavoring to find the locus and ownership of mineral locations from county recorders' records, was read and discussed. It has been suggested that the society memorialize the next legislature praying for the enactment of such laws as will assure more complete records.

Ohio State Tramway Association.—The next meeting will be held at Cincinnati, O., Nov. 21. The following papers will be presented: "Development of Motors during the Past Year"; "Steam and other Motors than Cable or Electricity", C. B. CLEGG, Dayton; "Cable and Horse", JOHN KILGOUR, Cincinnati; "Electricity", A. G. CLARK, Cincinnati; "Best Present Construction of Road Bed and Buildings", C. HATHAWAY, Cleveland; "Legal Decisions Affecting Street Railways, Favorable or Adverse; and Ohio State Laws at Present in Force", A. E. LANG, Toledo. H. A. EVERETT, of Cleveland, O., is the Secretary.

RAILROADS.

CONSTRUCTION NEWS.

East of Chicago.

Existing Roads.

Poughkeepsie & Connecticut.—About 300 hands have been put at work by contractor MCFADDEN on the line from Poughkeepsie, N. Y., north to Silvernails Bridge. ——The Massachusetts State Railroad Commission has granted a certificate of exigency for the construction of the Hartford & Connecticut Western extension from the Connecticut State line to Springfield, Mass.

Berkeley Springs & Potomac.—This short branch of the Baltimore & Ohio, from Hancock, Md., to Berkeley Springs, W. Va., 6 miles, has been completed and was opened for business on Nov. 1. The road will be operated by the Baltimore & Ohio.

New York, Mahoning & Western.—A press dispatch from Toledo says: "W. H. HARRIS, Vice-President of the New York, Mahoning & Western road, has returned from the East and says that in a few days there will be developments which will enable the company to secure funds to pay all liens and complete the road to Fort Wayne. The officers are doing all in their power to free the road from the unfortunate complications in which it became involved."

Toledo, Ann Arbor & North Michigan.—This company has about 400 teams and 850 men at work on the extension from Cadillac, Mich., to Manistee and Onekama. Grading is completed for 22 miles west of Cadillac and connection will be made with the Manistee & Northeastern Railroad before the end of the year.

Napanee, Tamworth & Quebec.—Work on this Canadian road is being pushed between Tamworth and Tweed. It is proposed to extend the line to Kingston.

Canadian Pacific.—The Town Council of Windsor, Ont., has voted to exempt this company from taxation for ten years. The company will build bridges over Sandwich, London and Wyandotte Streets. Other streets in the section of the town crossed by the railway are not to be opened till the increase of population requires it; and

bridges will then be built at the expense of the town. Several hundred men are now grading the section near London.——On the International extension in Maine, track is laid from the western terminus to Wilson's stream, 5 miles east of Greenville, a distance of 57 miles. The next 11 miles are ready for the rails, which will be laid as soon as the bridge across Wilson's stream is ready for trains. The bridge at Ship Pond will not be completed before the middle of January. On the line from Ship Pond east, about 35 miles of track are laid and tracklaying is in progress.

Fitchburg.—The directors of this company have voted to pass the semi-annual dividend. This is the first time such action has been taken by this company for over a quarter of a century.

Hoosac Tunnel & Wilmington.

HOLYOKE, Mass., Oct. 30, 1888.

EDITOR ENGINEERING NEWS:

We are at present extending our road over the Deerfield river by a bridge 300 ft. in length, to Readsboro, Vt., a distance of 1-2 mile. DANIEL H. NEWTON is President of our company and E. WALTHER is Chief Engineer.
H. T. & W. R. R. Co. per JAS. S. NEWTON.

Louisville, New Albany & Chicago.—A short line of 1¼ miles is under construction at Indianapolis, giving the company connection with the Belt line.

Hereford.—The trouble on this Canadian road with the laborers, who were defrauded of their wages through the sudden departure of the contractors, has broken out anew. The company agreed to pay the hands their wages for September on condition that they would give up their demand for their August wages. The company had not paid the contractors their September estimates, and the laborers deemed it just therefore that they should be paid for the work done for which the company still held the money. The company agreed to pay the September wages on Oct. 20, but on that day they put the men off with a promise of payment a week later. On Oct. 27 they informed the men that they would only be paid on condition that they signed a contract to continue in the company's employ till the railway was completed and also submit to a reduction of pay. The men struck at once, obtained arms, and marched to the village of Sawyerville, which surrendered unconditionally. The strikers took possession of the stores, secured liquor, and it is reported burned the house of one of the company's officials to light up their orgies. On Oct. 28 they began tearing up the railroad track, demolishing cars, etc. The militia were called out and dispersed the strikers after they had destroyed half a dozen flat cars and torn up a mile and a half of track. Prominent men of Sherbrooke have agreed to do all in their power to secure the men their wages and it is thought the matter will be settled without further trouble.

Turtle Creek Valley.—This road, of which 22 miles, from Turtle Creek to New Salem, Pa., had been built, has been purchased by the Pennsylvania Railroad Company. The line was projected by Geo. Westinghouse to open up the Murraysville natural gas field. Its charter permitted a line from Port Perry on the Baltimore & Ohio north to Saltsburgh, about 25 miles; and about $100,000 had been spent on the grading. Construction has been stopped for the present, but it seems likely that the company will eventually complete the road.

New Projects and Surveys.

Gloucester City & Atco.—The survey for this New Jersey road has been completed to within two miles of Atco. All the right of way through Gloucester has been obtained except 140 ft., and land for terminals has just been purchased at a cost of $7,500. A report is in circulation that the company is only working in a strategical way for the purchase of the Camden, Gloucester & Mt. Ephraim railroad from the Reading Company. GEO. A. MORRIS is Chief Engineer of the company with headquarters at Gloucester, N. J.

Collingwood & Bay of Quinte.—

COLLINGWOOD, Ontario, Oct. 27, 1888.

EDITOR ENGINEERING NEWS:—This company was chartered May 4, 1888. The proposed line will be 131 miles in length and will run from Collingwood to the Bay of Quinte on Lake Ontario. The country is easy for construction and the line will have easy grades and light curves. The principal traffic would be grain, as this is the shortest and cheapest connection from Chicago, Duluth and Port Arthur to Montreal, and has the best water route. The road will be independent and we expect Government aid. Bonds and stock will be issued to raise the remainder of the capital required. Surveys have not commenced, but FRANK MOBERLY is Chief Engineer. CHAS. CAMERON is President of the company.
C. MACDONELL, *Sec. & Treas.*

McKeesport & Bessemer.—Chartered in Pennsylvania to build a railway about 4 miles long, from McKeesport, Allegheny county, to a point in Mifflin township.

Coudersport, Hornellsville & Lackawanna.—Chartered in Pennsylvania to build a railroad from Coudersport, Potter county, to the New York State line, 22 miles. HENRY J. OLMSTEAD is Treasurer, and the principal office is to be at Coudersport.

Penobscot & Aroostook.—This company is to be organized at Bangor, Me., on Nov. 2. Among the projectors are EUGENE H. CLAPP, HORACE P. TOBEY and SAMUEL L. MONTAGUE.

Dexter & Piscataquis.—The articles of incorporation of this company, which is to extend the Newport & Dexter branch of the Maine Central to Dover, have been approved by the State Railroad Commission.

Buffalo & Williamsville.—This road will not be built till next spring; but it is stated that funds have been promised, and if a suitable entrance to the city can be obtained, the line will be pushed to completion early in the season. It is rumored that the Rome, Watertown & Ogdensburgh will reach Buffalo over this line.

Vincennes, Oakland City & Owensboro.—President J. C. RUDD is reported as confident that work will be pushed on this road next spring. All but 10 miles of the right of way is secured.

Oneida, Oneonta & New York.—This line is projected to run from Oneida, N. Y., *via* Vernon Centre, Knoxboro, Oriskany Falls, Waterville, North Brookfield, New Berlin, Morris and Laurens to Oneonta, a distance of 75 miles. The projectors are securing local aid and surveys will probably begin about Nov. 25, under direction of WALTER F. RANDALL, C. E., of Oneida.

SOUTHERN

Existing Roads.

Kentucky Union.—President F. D. CARLEY of Louisville states that a hundred miles of this road are under contract, and that trains will be running from Lexington into Breathitt county by next summer.

Carolina, Cumberland Gap & Chicago.—Col. JAS. G. GIBBES has completed the survey from Pickens, C. H. to Asheville, N. C. The distance from Aiken to Pickens is about 130 miles, on which ¾ of the grading is completed. This section runs through a county favorable for construction, and can be completed at small cost. The division from Pickens, C. H., to the French Broad river, 37½ miles in length, includes some heavy work and maximum grades of 80 ft. per mile and its estimated cost to build is $28,452. The division from the French Broad river to Asheville is 47 miles in length, and its estimated cost is $8,000 per mile.

Ohio Valley.—Christian county, Ky., will vote on Nov. 10, on the proposition to give this company a subsidy of $200,000 on condition that the company begins work within 60 days after the subscription is voted, and completes the extension from Princeton to Hopkinsville and southward to the State line in the direction of Florence Ala., within one year from the time of beginning work

Mt. Pleasant & Seaview City.—Work is progressing on the long trestle for this road at Charleston, S. C. It is stated that the company, which has been in need of funds, has marketed bonds and will be able to finish the line within the specified time.

Charleston, Cincinnati & Chicago.—This company has just received three coal burning engines from the Hinckley Locomotive Works. The track has been surfaced from Yorkville to Hickory Grove. Trains will begin running regularly between Rutherfordton, Columbia and Charleston within the next thirty days.

Georgia, Carolina & Northern.—The tracklayers on this road reached Chester, S. C., on Oct. 20.

Maysville & Big Sandy.—The track was laid to Newport, Ky., this week, and the line only awaits the completion of the Ohio River bridge, to drive the last spike.

Nashville & Tellico.—Track has been laid on this Tennessee road from Athens to Bright City, 22 miles. W. G. SEARS, of Athens, is Chief Engineer.

Louisville & Nashville.—A contract has just been let for constructing a short branch of the Birmingham Mineral railroad, 1¼ miles in length, from Sloss, Ala., to the top of Red Mountain. McTigh & Stallings are the contractors.

Atlantic Coast Line.—Grading is completed and track is being laid on the extension from Scotland Neck, N. C., to Bethel on the Albemarle & Raleigh Railroad, and the contract has been let for extending the road to Greenville. The Albemarle & Raleigh line is to be extended from Williamston to Plymouth, and surveys are in progress.

Marietta & North Georgia.—Messrs. C. J. Hambro & Son of London, are offering to investors bonds of this company to the amount of $1,000,000, and of the Knoxville, Cumberland Gap & Louisville Company to the amount of $1,500,000. The prospectus states that, "the bonds are offered for sale together as the two roads form in reality one line of railway, which will probably hereafter be consolidated." The death of Mr. R. M. PULSIFER will have no effect on the finances of the company as his interest in it was disposed of to other parties some time ago.

Kansas City, Fort Scott & Memphis.—The Richmond Terminal and Central of Georgia consolidation makes the city of Atlanta more anxious than ever to secure an extension of this line from its present terminus at Birmingham, Ala.

East Tennessee, Virginia & Georgia.—Certain stockholders of this company have brought suit to prevent the lease of this system to the Richmond & West Point Terminal Company. The suit will be heard at Knoxville, Tenn., on Nov. 16.

Louisville Southern.—This company will remove its repair shops from Louisville to Harrodsburgh, Ky.

New Projects and Surveys.

Genesis & Obed River.

GENESIS, Tenn., Oct. 29, 1888.

EDITOR ENGINEERING NEWS:

The Genesis & Obed River R. R. is to be about 25 miles in length, and 15 miles have been surveyed and the right of way secured. The company owns mineral and timber lands, and was to let contracts on Oct. 1, but the letting was postponed without date. Capt. LINA BEECHER is President and General Manager. J. B. HOLMES.

Owensboro, West Louisville & Sebree City.—A preliminary organization of this Kentucky company has been effected, and surveyors are soon to be put in the field to run a line from Owensboro southwest *via* Calhoun, Beech Grove, West Louisville, Curdsville, and Sorghotown to Sebree City, Webster county, Ky.

Huntington & Guyandotte River.—Surveys are in progress on this West Virginia road. The Norfolk & Western road has been tapped at Pineville, Wyoming county, and will follow the Guyandotte river to the terminus at Huntington.

Dayton & Faunsdale.—King & Hannon have the contract for this Alabama road, 8½ miles in length. R. W. PRICE, of Dayton, is President.

Atlantic, Atlanta & Great Western.—The stockholders of this company are to hold a meeting at Eatonton, Ga., on Nov. 6. Two corps of surveyors are in the field, one working on the final location of the division between Atlanta and Eatonton and the other on the division between Eatonton and Savannah. Right of way is being secured and President FRY claims that ample funds are in hand for building the road.

THE NORTHWEST.

Existing Roads.

Northern Pacific & Manitoba.—This company has not yet succeeded in its attempt to lay a crossing over the Canadian Pacific tracks near Winnipeg. The original Court injunction obtained by the Canadian Pacific company was dissolved on Oct. 25; but before an attempt could be made to force a crossing, the Canadian Pacific secured a second injunction, which is still in force. The Government workmen succeeded in laying crossings at Headingly and Morris, but they were immediately torn up by the Canadian Pacific forces. On Oct. 30 the Canadian Pacific bridge across the Red river at Winnipeg was set on fire; but the flames were extinguished after a hard fight. The Canadian Pacific claims in behalf of its action in preventing the crossings that the Northern Pacific & Manitoba officials have neglected to secure any legal right to make a crossing of the Canadian Pacific line. The law provides that when two companies cannot agree on terms for the construction and maintenance of necessary crossings, recourse may be had to the Railway Committee of the Privy Council, which shall adjust the matter equitably. It is said that the Manitoba officials have wholly neglected to proceed according to law in the matter.

At the Northern Pacific office in this city the statement is given out that this company is in no way interested in or concerned with the Manitoba struggle. The Provincial Government of Manitoba is building the lines of railway whose construction is being resisted, and will on completion turn them over under a lease to the Northern Pacific & Manitoba company. The only relation of this corporation with the Northern Pacific is a traffic contract with a leased line of the latter company.

Eastern Minnesota.—For the first month of operation this road reports a traffic from Minneapolis to the lake of 60,000 barrels of flour and a traffic from the lake, south, of 1,400 car-loads.——A sinkhole about 11 miles from West Superior is giving considerable trouble.

Missouri Pacific.—The Nebraska extension from Talmage to Crete, 80 miles, was opened for business on Nov. 1.

Winona & Southwestern.—About 5 miles of track are laid and 15 miles of grading done. Bids are asked for the tunnel, 21 miles west of Winona. D. M. WHEELER, of Winona, is Chief Engineer.——A delegation from Sioux City, Ia., has paid a visit to Winona and will try to present substantial inducements to the company to make Sioux City the western terminus instead of Omaha.

Chicago, Burlington & Quincy.—A decision has been announced by the Nebraska Supreme Court in a suit brought by the Attorney General against the company, the effect of which, it is said, will be to permit a closer consolidation of the Burlington & Missouri River system with the parent company than has heretore been possible.

New Projects and Surveys

St. Louis & Northwestern.—The surveying party on the St. Louis & Omaha line will reach Leon, Ia., by Saturday. The party will then come back to the State line and make another survey through Seymour and Corydon. The line from Kirksville to Unionville by the survey is 31 1-2 miles, while an air line between the two points is 30½ miles. It will be seen that the survey is almost an air line from here to Unionville. It is reported on good authority that a syndicate composed of St. Louis capitalists is making an effort to secure the road and extend it to St. Louis and Omaha. The movement is the result of the organization of the St. Louis & Omaha company, which is now making the survey.—*Kirksville (Mo) Graphic.*

Sault Ste. Marie & St. Ignace.—Chief Engineer GEO. COX of St. Ignace, Mich., will make a new survey for this road during the early winter. WM. CHANDLER of Sault Ste. Marie is President of the company.

THE SOUTHWEST.

Existing Roads

Texas & Pacific.—The Receivership of this company was terminated on Oct. 30.

Southern Pacific.—Contractors Ricker, Lee & Co., of Galveston, who are grading the extension from Victoria to Beeville, Tex., will have it ready for the rails, before the end of the year.

Atchison, Topeka & Sante Fé.—The annual report of the company to the Kansas State Board of Railroad Commissioners has been filed at Topeka. It gives the total earnings of the road for the year ending June 30 as $16,544,392,75, while the total expenses for the same period were $20,061,502.86. The earnings were derived from the following sources: Freight, $10,538,461.67; passenger, $489,611.14; mail, $405,744.06; express, $355,895.41; telegraph, $908,789,69; rents, $375,104.91.

The expenses during the year were: Total expenses, (exclusive of construction, equipment, real estate, and right of way), $10,140,429.69; taxes, $585,417.26; rentals, $1,509,300.50; interest (on the lands of the Atchison, Topeka and Santa Fé), $2,057,820.01; dividends, $4,777,939.75; other expenses, $880,685.65; total, $20,061,502.86.

The report shows that the amount of stock issued is $75,006,000, of which $10,096,750 was issued this year for construction and equipment of new lines. Bonds were issued during the year to the amount of $12,286, making a total bonded debt of $69,995,000.

A report is in circulation that JAY GOULD is quietly securing a controlling interest in the stock for the purpose of stopping its competition with the Missouri Pacific.

Denver, Texas & Fort Worth—A press dispatch from Pueblo, Col., stated that the Missouri Pacific company had acquired control of this company,—a report which has probably as little foundation as the one noted in the preceding paragraph.

New Projects and Surveys.

Kansas City, Watkins & Gulf.—

LAKE CHARLES, La., Oct. 19, 1888.

EDITOR ENGINEERING NEWS:

The Kansas City, Watkins & Gulf Ry., is projected to extend in an air line from Lake Charles, La., to Kansas City, *via* Shreveport, La., and Texarkana and Fort Smith, Ark. There are easy grades to the middle of Arkansas, after which it is quite rough. The road runs through the finest long leaved pine on the continent, in Louisiana and Arkansas; and oak and all kinds of hard woods abound along the route. Pine lumber, hard wood timber and farm products will furnish the principal freight. There will be one 200 yd. bridge over the Calcasieu river, and at the Sulphur and Red rivers, bridges of 200 or 300 yds. Surveys have been made for a distance of 175 miles and some of the towns have voted the company a 2½ mill tax. We hope to begin tracklaying in 6 months and have part of the line open for traffic within one year from date. J. B. WATKINS is President and P. H. PHILBRICK is Chief Engineer. A. THOMSON.

ROCKY MOUNTAIN & PACIFIC.

Existing Roads.

Yreka Branch.—Over half the grading is done on this line from Yreka, Col., to connect with the Southern Pacific's California & Oregon Railroad at Montague. Rails are on the way and the line will be finished and put in operation at once.

Montana Central.—The first train through the Wickes tunnel was run Oct. 24. The tunnel is 6,200 ft. in length and was begun in May, 1887. The contractors were Larson, Keefe & Co., of Helena. The tunnel is to be lined with masonry at an early date.

Northern Pacific.—It is stated that a line will be built next year from Deep Creek, 13 miles west of Spokane Falls, to the British Columbia frontier. The following suggestive note is contained in a letter from Rumsey, Montana, to the Helena *Herald*:

The railroad is completed to this place, and regular traffic has commenced. Rumors were in circulation for a day or two previous to the driving of the last spike, that certain parties who consider themselves injured would forcibly prevent the completion of the road, but no attempt in that direction was made when it became known that three men with Winchesters commanded the gulch from a central point.

The line from Cheney to Davenport, W. T., under construction by contractor G. W. HUNT, will be finished by Dec. 1.

Los Angeles & Glendale.—This company will issue bonds to secure funds for the extension of its road to Pasadena. JOHN CROSS is President.

Seattle, Lake Shore & Eastern.—The annual meeting of this company was held at Seattle, W. T., on Oct. 18. Reports were submitted showing gratifying progress on the road by the president and manager. The following board of directors was elected for the ensuing year; JAMES D. SMITH, M. S. PATON, J. F. ALEXANDER, T. M. LOGAN, G. W. BUTTS, Jr., D. H. GILMAN, J. R. MCDONALD, F. H. OSGOOD, L. C. GILMAN, T. T. MINOR, G. G. LYON, and W. R. THARNELL. G. W. HUNT has completed his contract on the road. The cost of construction was nearly $25,000 per mile.

Oregon Ry. & Navigation Co.—The right of way across the Cœur d'Alene Indian reservation has finally been secured. The extension, which is known as the Washington & Idaho Railroad, is completed from Farmington to the reservation; and on the other side the line is graded to Mullan, Idaho, 100 miles. The distance to be built across the reservation is 53 miles through a rather rough country containing some heavy work. J. H. Smith, of Portland, Ore., has the contract and will put on a large force at once to complete the line. —It is announced that the company has effected a compromise with the Northern Pacific by which both companies will use the same track through a narrow canyon between Wallace and Mullan, Idaho.

Northern California.—The extension from Marysville to Knight's Landing is making good progress. The company expects to have about 18 miles finished by the end of the year and the remainder will be finished in the spring.

Carson & Colorado.—Another survey has just been made for the extension proposed from Keeler to Mojave, Cal.

Mexican National.—A visit is to be paid this month to Matamoras by the officials of this company, and a decision will then be made as to whether the Matamoras & Monterey road shall be built to Cearalvo or to Laredo, or whether the concession shall be given up.

Chicago, Burlington & Quincy.—The Denver *Republican* publishes a lengthy account of the plans and surveys which the managers of this company are supposed to have in hand for extensions to various points in Colorado and to Salt Lake City. It is stated that there are valuable coal fields near Ft. Collins, Col., which can be reached by the construction of a few short extensions. If this be true, the company may take steps to tap them soon; but there is no likelihood of any general extension policy being adopted by the company for a good while to come.

New Projects and Surveys.

Tehuantepec.—It is announced that the contract for the completion of this railroad across the isthmus of Tehuantepec has been awarded, and that the Mexican Government will grant no more subsidies to railways.

Proposals Open.

Water-Works.—For corporation of South Denver. Cost about $160,000. J. A. FLEMING, Mayor, Mendota Block, Denver, Col.

Viaduct.—Iron viaduct on 16th St. GEO. E. RANDOLPH, Superintendent, or ROBT. GILHAM, Engineer, Denver City Cable Ry. Co., Denver, Col.

Sewer Pipe.—T. A. HUGUENIN, Superintendent of Streets, Charleston, S. C.

Street Lighting.—About 50 arc lights of 2,000 c. p., and about 250 incandescent lights of 20 c. p., or the equivalent thereof of gas lights. GEO. A. DUNCAN, Mayor, Burlington, Ia. November 5.

Water Pipe.—Cast-iron pipe, 500 lengths. Bids per gross ton. MARTIN FINCK, Secretary, Board of Public Works, Jersey City, N. J. November 5.

Street Work.—GEO. H. SIMPSON, City Engineer, Terre Haute, Ind. November 6.

Water-Works.—Masonry filter gallery. JOHN W. HILL, Consulting Engineer, Findlay, O. November 8.

Sewers.—At Pine Bluff, Ark. Date of opening bids postponed. J. H. HANEY, Consulting Engineer, Little Rock, Ark. November 10.

Sewer.—About 500 lin. ft. of 18-in. pipe, 20 cu. yds. concrete, 400 cu. yds. rock excavation. MARTIN FINCK, Secretary, Board of Public Works, Jersey City, N. J. November 12.

Bridge.—Iron bridge, 50 ft. long, 12 ft. wide, two 15 ft. approaches. THE COUNTY COMMISSIONERS, Forth Worth, Tex. November 12.

Boring.—Boring for water on Blackwell's Id. THE COMMISSIONER OF PUBLIC WORKS, 31 Chambers St., New York City. November 13.

Street Work and Sewers.—THE COMMISSIONER OF PUBLIC WORKS, 31 Chambers St., New York City. November 13.

Viaduct.—Over railway tracks on Q. St.; 570 ft. of pile trestle, one 50 ft. through truss, one 106 ft. and one 150 ft. through truss; separate bids for wood and iron combination Howe trusses and steel trusses; length, 876.10 ft.; width 32 ft. (20 ft. roadway and two 5 ft. sidewalks); live load, 100 lbs. per sq. ft.; dead load (on trestle), 50 lbs. per sq. ft. Bonds for $35,000 have been voted. D. F. BAYLESS, Chairman of Committee on Streets, South Omaha, Neb. November 24.

Sewer Bonds.—Readvertisement of bonds for $150,000. THE CITY CLERK, Helena, Mont. November 24.

GOVERNMENT WORK.

Breakwater.—Rip-rap foundations for 600 ft. of breakwater. Appropriation, $12,000. Major L. COOPER OVERMAN, U. S. Engineer Office, Cleveland, O. November 6.

Dredging.—In Boston harbor. Lt. Col. G. L. GILLESPIE, U. S. Engineer Office, Boston, Mass. November 8.

Dredging and Revetment.—(1 Dredging west channel of Saginaw river along West Bay City, Mich.; (2) dredging bar at mouth of Saginaw river; (3) revetment, beam wall and dredging at Carrollton, Saginaw river. Col. O. M. POE, U. S. Engineer Office, Detroit, Mich. November 14.

Dredging.—In Norfolk harbor and Elizabeth river. Lieut. G. J. FIEBEGER, U. S. Engineer Office, Norfolk, Va. November 20.

Harbor Work.—Improving entrance to Humboldt bay, California. Major W. H. HEUER, U. S. Engineer Office, San Francisco, Cal. November 30.

Contracting.

The Thomson-Houston Electric Co., of Boston Mass., has moved into new offices in the Hathaway Building, 620 Atlantic Ave.

Electric Railways.—Owners of electric motors for street railways should address VAN AUKEN & MEAD, 100 Opera House, Denver, Col.

The Hydro-Pneumatic Mfg. Co., of Chicago, has been incorporated by J. W. POWERS, F. BENOIT, F. M. WELLER, and others, to manufacture hydraulic and pneumatic plant. Capital stock, $100,000.

Wells.—The Cook Well Co., of St. Louis, Mo., has been awarded a contract for two 7-in. wells, with pumps complete, at Aurora, Neb.

Streets and Roads.—At Little Rock, Ark., an improvement district has been formed for improving about 1½ miles of streets.——The County Court, at Little Rock, has appropriated $25,000 for road purposes.

Pipe Works.—The Anniston Pipe Works, of Anniston, Ala., will increase the capital stock from $200,000 to $500,000. Extensive works are being erected.

Car Works.—The United States Rolling Stock Co. is rapidly completing its new works at Decatur, Ala., and by the end of the year will be turning out cars. The company has already received several orders.

The Union Switch & Signal Co., of Pittsburg, Pa., is putting in a number of its interlocking switches for experimental purposes on railroads in Illinois, Indiana and Western States.

Drainage.—The New York Life Insurance Co. has accepted the proposal of the Durham House Drainage Co., of New York, for furnishing the drainage system of its 10-story office building, 100x100 ft., in St. Paul, Minn., for $5,355.

Water-Works.—VAN AUKEN & MEAD, of Denver, Col., want addresses of contractors for water-works material; and also wish correspondence with contractors desiring to do work in Colorado or Wyoming on contract or on franchise.

The Louisiana Artificial Stone Paving Co. has been incorporated at New Orleans, La., to establish works for the manufacture of artificial stone. President, ARTHUR HAUCK; Vice President, EDWARD H. CHADWICK; Treasurer, A. B. LACOSTE; Secretary, WM. ARDELL.

Draw Bridges.—The Vulcan Iron Works, of Chicago, Ill., have the contract for the swinging machinery for the Chicago, Madison & Northern R. R. Co.'s bridge at Chicago. Also the contract for the Oregon Railway & Navigation Co.'s draw bridge over the Snake river, at Riparia, Wash. Ty.

The Occidental Construction Co. has been incorporated at San Francisco, Cal., to build and operate gas works, electric light and water-works. Capital stock, $500,000. L. L. BROMWELL and H. WADSWORTH, of Oakland; GEO. W. LYNCH, of Los Gatos; JOHN D. YOST and M. A. NEWELL, of San Francisco.

The San Diego Construction Co. has been incorporated at San Diego, Cal., by W. S. WATERMAN, T. J DALEY, W. G. RIFENBURG and F. T. HILL. The company proposes to undertake general contracting work for railways, street railways, piers, bridges, etc. Capital stock, $100,000.

Creosote Works.—Extensive creosoting works are to be established at Seattle, Wash. Ter., and a plant with a capacity of 100 piles has been built by the Richmond Locomotive Works, of Richmond, Va., at a cost of $125,000. The logs will be first steamed and then creosote forced into the tanks at a pressure of 250 lbs. per sq. in. The works will be owned by the Puget Sound Creosote Co.

Metal Markets.—***Structural Iron.***—Prices are about as follows: in Philadelphia 2.10c. @ 2.15c. for bridge plate; 2c. @ 2.10. for angles; 2.6c. @ 2.7c. for tees, and 3.3c. for beams and channels, iron or steel. Store prices are as follows in Chicago: angles, 2.35c. @ 2.50c; tees, 2,60c. @ 2.70c.; beams, 3.80c. Mill orders are taken at the following rates, f. o. b. Chicago. Angles, 2.20c. @ 2.25c, universal plates, 2.23c. tees, 2.55c. @ 2.65c; beams and channels, 3.40c. On combination orders, in which angles form a part, prices have recently been seriously cut. New York prices are sheared plates, 2c. @ 2.1c. universal mill plates, 2.1c. @ 2.2c; angles, 2.1c. @ 2.15c; tees, 2.4c. @ 2.6c, and channels and beams, 3.3c.

Railway Track Supplies.—Pittsburgh, Pa. Prices remain unchanged. Spikes, 2c. 30 days, delivered; splice bars, 1.80c. @ 1.85c; track bolts, 2.85c. with square and 2.95c. with hexagon nuts.

Old Material.—There is a fair demand, and prices are steady. No. 1 wrought-scrap, $21, net ton; car axles, $26 @ $27; cast scrap, $16, gross; cast borings, $12.50 @ $13; car wheels, $20. (From the *Iron Age*, Nov. 1.)

The Indianapolis Paving Co. has been incorporated at Indianapolis, Ind., by J. C. NEW, J. A. MOORE, N S. VYRAM, and others. Capital stock, $40,000.

Gauges.—The Vacuum Oil Co., of Rochester, N. Y., has adopted the Edson pressure recording gauge on its boilers.——The recorders have been purchased for water at Sandy Hill, N. Y., and for water and steam by the Manchester Water Co., of Manchester, Va. J. B. Edson, New York, reports business active and satisfactory.

The Tuerk Vapor Pressure Cylinder Hydraulic Elevator is a new motor lately introduced by the Tuerk Hydraulic Power Co.,of this city. Its claims are that it is simple, safe, automatic, durable and economical, and it combines in one steel or iron cylinder a pump, pressure tank and reservoir. It is in use and the testimonials as to its merits are satisfactory. The company will furnish further details and estimates on application.

Timber Preservation.—The Seattle Cement & Timber Preserving Co. has been incorporated at Seattle, Wash. Ty., to acquire and dispose of patent rights for Overlack cement, an article designed for preserving timber, and to deal in cement and any other article serviceable as a timber preservative; to apply the cement for preserving piles, wharf timbers, railroad ties, etc.; to manufacture piles, etc., and treat them with the cement; to contract for the construction of bridges, wharves, etc.; and to do all other necessary things for carrying on a business of the nature indicated. The incorporators are O. S. CARR, W. J. JENNINGS, ANGUS MACKINTOSH, F. H. WHITWORTH, L. S. ROWE, C. P. STONE, C. B. BAGLEY, and W. R. THORNELL. Capital stock, $50,000.

Outfall Sewer.— At Los Angeles, Cal., the City Surveyor has prepared plans for an outfall sewer, which will discharge 23,760,000 galls. per day, and will accommodate a population of 200,000; there will be 4,292 ft. of 24x36-in., 9,000 ft. of 26x39-in., 16,920 ft. of 32x48-in., 4,000 ft. of 30x52-in. and 24,825 ft. of 36x53-in. Entire distance, 69,037 ft. Estimated cost; if built of brick:

1,127,000 brick at $20 per 1,000 laid in wall	$225,400
69,037 ft. of excavation	69,000
Bridge at Ballona creek	5,600
	$300,000

If laid with concrete:

Concrete work	$229,821
Trench	69,000
Bridge	5,600
	$301,421

Foundry.—The El Paso Foundry & Machine Works, of El Paso, Tex., will soon be in operation, and will be an important enterprise as the works are said to be of considerable size. A. W. DUTTON is Superintendent.

Electric Railway.—*Washington, D. C.*—The latest electric railway of the Thomson-Houston Electric Co.,the Eckington & Soldiers' Home Street Railway, of Washington, D. C., of which Mr. GEORGE TRUESDELL is President, has been in operation since the 15th of October. This road, which is one of the finest and most ornamental roads that this company has constructed, is 2¼ miles in length, and is built along New York Ave., terminating at the corner of 7th St. The first trial trip was made October 15, the party including President TRUESDELL, Capt. EUGENE GRIFFIN, and Mr. G. W. MANSFIELD, of the Thomson-Houston Railway Co., and several street railway managers who were in Washington attending the Street Railway Convention. After inspecting the engine and dynamo in the new building erected at the Eckington end of the line, the visitors boarded one of the new cars, which were made specially for this road. These cars are very handsome, although the exterior does not differ much from the ordinary street cars; the interior is nicely fitted up with slate-colored plush cushions and electrical lamps which illuminate the car so that a newspaper can be easily read anywhere in it, and other appliances which are found in other cars of first-class construction. In spite of the fact that the road was new and that the cars had never been run over it before, excellent time was made on the first trip and without accident of any kind. The car ran smoothly over the roadway, ascending the grades and passing around the curves without any apparent additional exertion more than when on the level. On Oct. 18, at the invitation of the Thomson-Houston Electric Co., the delegates of the Convention of the American Street Railway Association inspected the road from end to end and carefully noted all the points in the overhead construction, the construction of the motor truck and the electrical appliances in general. They all, without exception, say that it is the finest electric railway that is in operation at the present time in the United States, and that it possesses features of superiority in form of construction and ease and certainty of operation not possessed by any other system in use at the present time. The dynamo is 80 H. P., engine 100 H. P., used for supplying the current. The electric part of the road will be run by the Thomson-Houston Electric Co. for three months, after which the company will assume charge. Mr. TRUESDELL, President of the road, has assured the Thomson-Houston Co., through its representatives who were in Washington when the road was started, of his perfect satisfaction at the way in which the cars operated on the trial trip, and says that he is confident that the road will be successful in every particular.

Pier and Roof.—Shaller & Schniglau, of Chicago, have been awarded the contract for building the substructure and superstructure of the extension of the iron pier at Marine Park,Boston. Also the contract for the iron roof of the central pumping station, at Chicago.

Cement.—The following proposals for furnishing 1,000 barrels of Portland cement have been received by the Dock Commissioners, New York City: James Brand, $2.25 per bbl.; E. Thiele, $2.37½; Erskine W. Fisher, $2.45; Eckmeyer & Co., $2.75. The contract was awarded to James Brand.

Levee.—The following contracts for the work of improving Sny Island levee where it crosses Snicarte slough and other sloughs, and repairing washouts, have been awarded by Capt. E. H. RUFFNER, U. S. Engineer Office, Quincy, Ill.: Wm. H. Raptery, Pittsfield, Ill., Godman's crevasse, 14 cts.; Reese H. Price and Patrick H. King, Topeka, Kan., 10.9, 11¼ and 12 cts.; Zachariah Fielding, Hannibal, Mo., Iowa cut-off, 20 cts.; A. J. Whitney, Rock Island, Ill., Sny dam, 16 cts.; Wood & Penny, Warsaw, Ill., 16 cts.

Cable Railway.—*St. Paul, Minn.*—The St. Paul City Railway Co. has awarded contracts as follows in connection with the new cable line on East Seventh St. Two 500 H. P. engines, E. P. Allis & Co., of Milwaukee, Wis.; three 208 H. P. boilers, Babcock & Wilcox, of New York; cable driving plant, Pool & Hunt, of Baltimore, Md.; cast-iron yokes, covers, etc., St. Louis Car Wheel Co., of St. Louis, Mo.

Dredging and Pier Work.—The Dock Commissioners have awarded the contract for dredging at Pier 18, East River, to the Union Dredging Co., the only bidder, at 20 cts. per cu. yd.——The following proposals for removing pier and building new pier and bulkhead at E. 38th St., East River, have been received by the Dock Commissioners: Joseph Walsh, dredging around cribs, 40 cts. per cu. yd.; crib dredging, $1.28 per cu. yd.; excavation for new crib work, $3,000; pier, $14,400; rip-rap stone, 70 cts. per cu. yd.; Richard Cronin, 40 cts., $1.30, $3,694, $16,440, 75 cts.; John W. Flaherty, 44 cts., $1.40, $3,346, $17,437, 75 cts. The contract was awarded to Joseph Walsh.

Sewers.—*Middletown, N. Y.*—The following bids were received by C. PH. BASSETT, of Newark N. J., the engineer in charge: B. Van Vranken, Schenectady, N. Y.; 2,210 ft. of 20-in. pipe, $1.30; 88 20-in. Y's, $2 each; 760 ft. of 18-in. pipe and 30 Y's, $1.50 and 90 cts.; 1,070 ft. of 15-in. pipe and 43 Y's,$1.30 and 75 cts.; 1,550 ft. of 12-in. pipe and 62 Y's, 75 cts. and $1.20; 193 ft. of manholes, $2.85 per ft.; 10,000 lbs. of iron, 3 cts. per lb.; total, $7,035.85. A. Miller, Saratoga, N. Y.; 20-in. pipe and Y's, $1.22½ and $1.75; 18-in., $1.05 and $1.30; 15-in., 88 cts. and $1; 12-in., 76 cts. and 65 cts.; manholes, $5; iron, 3 cts.; total, $7,166.15. J. Conway & Co., Newark, N. J.; 20-in. pipe and Y's, $1.64 and $1.50; 18-in., $1.49 and $1; 15-in., $1.35 and 85 cts.; 12-in. $1.30 and 60 cts.; manholes, $3.25; iron, 2 cts.; total, $9,279.30 V. B. Wakeman, Middletown, N, Y.; 20-in. pipe and Y's, $2.20 and $7; 18-in., $2 and $5.75; 15-in., $1.80 and $4.75; 12-in., $1.60 and $3.75; manholes, $6; iron, 4 cts.; total, $13,571.25. C. W. Cairns, Middletown, N. Y.; 20-in. pipe and Y's, $1.80 and $7; 18-in., $1.70 and $5; 15-in., $1.30 and $4; 12-in., $1.30 and $4; manholes, $6; iron, 4 cts.; total, $11,420. J. W. Hamilton, Middletown, N. Y.; 20-in. pipe and Y's, $1.81 and $5.07; 18-in., $1.52 and $3.83; 15-in., $1.20 and $2.82; 12-in., $1.05 and $1.92; manholes, $6; iron, 3½ cts.; total, $10,376.16. B. Van Vranken; rock, $4; concrete, $4; timber, $25; J. Conway & Co., $3, $13, $30; V. B. Wakeman, $2, $3, $25. C. W. Cairns, $4, $4, $30.

Newark, N. J.—The following contracts have been awarded by ERNEST ADAM,City Surveyor: P. H.Harrison, pipe, 95 cts.; basins, $96; manholes, $27. Conway & McManus, pipe, 90 cts.; basins, $90; manholes, $30.

Water-Works.—*Lebanon, Ky.*—The city has awarded the contract for water-works, complete, to the Scovel & Irwin Construction Co., of Nashville, Tenn.; the company is to take 6 per cent. city bonds in payment. There will be a 1,250,000 galls. reservoir, of earth and stone, on a knob 480 ft. above Rolling Fork creek, the source of supply; an 8-in. rising main 8,500 ft. long; a 10-in. supply main 12,500 ft. long, and about 4 miles of 10, 8, 6, and 4-in. pipe, with 40 hydrants on the distributing system. Water will be taken from the river by a filter gallery and also direct from a crib and strainer in mid stream, and pumped into the reservoir by a Gordon Steam Pump Co.'s 16 and 29 in. x 10¼ x 18-in. duplex compound pump, with outside packed plungers and independent condenser. Dennis, Long & Co., of Louisville, Ky., will furnish the pipe and specials; the Union Iron Works, of Chattanooga, Tenn., the boilers; and the Bourbon Copper & Brass Works, of Cincinnati, O., the valves and hydrants. The cost of the plant complete will be about $60,000. The city now suffers from a scarcity of potable water in dry spells and is almost without any fire protection. The contractors expect to complete the plant in 4 months.

Troy, Ala., and Brownsville, Tenn.—J. Walker Bates & Co.,of New York, who have franchises for water-works at these places,have awarded to the Scovel & Irwin Construction Co., of Nashville, Tenn., the contract for building the water-works plant at Troy, Ala., and for pipe and pipe laying for the water-works at Brownsville, Tenn, The company has not yet contracted for material for these works. It is expected to complete the work at both places in about 4 months, unless delayed by bad weather. The Troy works will cost about $75,000.

Vassar, Mich.—On Oct. 8 the contract for a complete system of water-works was awarded to the Michigan Pipe Co., of Bay City, Mich. The pipe will be the improved Wyckoff water pipe. The plant will consist of 3,750 ft. of 4-in., 13,300 ft. of 6-in., 3,100 ft. of 8-in., and 2,350 ft. of 10-in. discharge pipe, and 300 ft. of 10-in. suction pipe; 54 double discharge hydrants; 13 valves; 20,000 lbs. of special castings; stand-pipe,18 ft. high by 15 ft. diameter; Gaskill pumping engine, 18 x 18 in. steam cylinders and 12 x 18-in. water cylinders; boiler, 54 ins. diameter by 14 ft. long, and brick pump house. The works are to be completed and in operation by Jan. 1, 1889. The works will cost $29,000.

Government Work.—*St. Clair Flats Canal, Michigan.*—The following proposals for revetment construction at the St. Clair Flats ship canal have been received by Col. O. M. POE, U. S. Engineer Office, Detroit, Mich.; Augustus J. Dupuis, Detroit, $7.94 per running ft.; Candler Bros., Detroit, $8.50; Luther E. Allen, Charlevoix, Mich., $8.59; Hubbell & Sheldon, Detroit, $0; Kerr & Stang, Lorain, O., $9.95; Chas. H. Stoughton, Cleveland, O., $12.50; J. L. Gearing, Detroit, $12.71.

St. Mary's River, Michigan.—The following proposals for excavating and building dikes were opened Oct. 22 by Col. O. M. POE, U. S. Engineer Office, Detroit, Mich.: C. F. & H. F. Dunbar, Buffalo, N. Y., $1.80 per cu. yd.; Hickler & Greene, Sault Ste. Marie, Mich., $2.12, $2.25, $2.40; Carkin, Stickney & Cram, East Saginaw Mich., $2.25, $2.19½, $2.70; C. S. Barker, Duluth, Minn., $2.98, $3, $3.15; Williams, Upham & Co., Duluth, $3.10 $2.90, $3.40; L. P. & J. A. Smith, Cleveland, O., $3.35, $3.15, $3.30.

Kewaunee Harbor, Wisconsin.—The following proposals for pier extension have been received by Major CHAS. E. L. B. DAVIS, U. S. Engineer Office, Milwaukee, Wis.: For 12,600 lin. ft. of round piling; F. M. Knapp & E. Gillen, of Racine, 19 cts.; H. Truman & Geo. Cooper of Manitowoc, 22 cts.; C. H. Starke, of Milwaukee, 25 cts. For 48,600 ft. B. M. of Norway sheet piling, $29, $30, $32; For 18,400 ft. B. M. of white oak timber, $49, $48, $50; for 630 lin. ft. of 6×12 white pine timber, 16 cts., 20 cts., 40 cts.; for 3,600 ft. B. M. of white pine plank, $15.50, $18, $25; for 450 cords of stone $5.50, $6, $7; for 8,000 lbs. of wrought-iron screw bolts and tie rods, 5¾ cts., 6 cts., 6 cts.; for 900 lbs. wrought-iron spikes, 4¼ cts., 4 cts., 6 cts.; for 520 lin. ft. of 12×12 white pine timber, 25½ cts., 28 cts., 40 cts.; totals, $7,968.10, $8,663.60, $9,855.20.

Sheboygan Harbor, Wisconsin.—The following proposals for pier extension were opened Oct. 22 by Major CHAS. E. L. B. DAVIS, Milwaukee, Wis.: 12×18 and 12×12 pine timber; Knapp & Gillen, of Racine, 27 cts.per lin. ft.; Chas. Berner, of Green Bay, 30 cts.; Truman & Cooper, of Manitowoc, 28 cts.; C. H. Starke, of Milwaukee, 35 cts.; 12×18 and 12×12 hemlock timber, 23½ cts. per lin. ft., 24 cts. 23 cts.,30 cts.,pine plank, $15.50 per M., $17, $18, $25; stone, $6.75 per cord,$6.50, $5.75, $7; W. I. drift bolts,3 cts. per lb., 3½ cts., 3 cts., 4 cts.; W. I. screw bolts, 4 cts., 4½ cts.,4 cts.,5 cts., W. I. spikes, 4 cts., 4 cts.,4 cts., 5 cts.; piles, $10.50 each, $9, $9, $15; totals,$11,423.50; $11,556.10,$10,656.60, $13,739.50.

Manitowoc Harbor, Wisconsin.—The following proposals for rebuilding superstructure were opened Oct. 22, by Major CHAS. E. L. B. DAVIS, Milwaukee, Wis.: white pine timber; Chas. Berner, of Greene Bay, 30 cts. per lin. ft., Truman & Cooper, of Manitowoc, 30 cts.; C. H. Starke, of Milwaukee, 35 cts.; pine plank, $16.60 per M., $20, $25; stone, $6 per cord, $5.75, $7; W. I. drift bolts, 3½ cts., 3 cts., 4 cts.; W. I. spikes, 3½ cts., 4 cts., 5 cts.; totals, $3,187,94, $3,120.80, $3,736. 50.

Kanawha River, West Virginia.—The contract for building Lock No. 7, on the Great Kanawha river improvement,has been awarded by Col. WM. P. CRAIGHILL, U. S. A., to Carkin, Stickney & Cram, East Saginaw, Mich., at the following prices: grubbing and cleaning complete, $2,000; 48,000 lin. ft. of crib logs in coffer dam, 28 cts. per lin. ft., $13,440; 27,000 ft. B. M. of sheathing, $30 per M. $810; 7,200 cu. yds. coffer dam filling, 60 cts., $4,320; 24,000 cu. yds. excavation, 55 cts., $13,200; 500 cu. yds. of rock excavation, $4.80, $3,400; 800 cu. yds. of embankment, 50 cts., $4,000; 400 cu. yds. of puddling. $1.50, $600; 600 cu. yds. concrete, $5, $3,000; 5,800 cu. yds. backing masonry, $4.40, $25,520; 1,900 cu. yds. rock face masonry $8.60, $16,340; 1,500 cu. yds. pointed face masonry, $9, $13,500; 260 cu. yds. cut stone masonry, $12, $3,120; 230 cu. yds. sill, $18, $3,960; 75 cu. yds. quoins, $25, $1,875; 340 cu. yds. coping, $25, $8,500; 3,300 cu. yds. stone filling, $1.50, $4,800; 2,200 cu. yds. rip-rap, hand placed, $3, $6,600; 950 cu. yds. paving, $5, $4,750; 69,000 ft. timber in permanent construction, $40 per M; 1,200 bolt holes in masonry, 50 cts. per lin. ft., $600; total, $136,065. The other bids were as follows: Higgs, Calderwood & Littlepage, Charleston, W. Va, $147,694; Ruffner & Grady, Charleston, W. Va., $155,717; Hoag & Petitdidier, Cincinnati, O., $160,108; C. I. McDonald, Pittsburg, Pa., $160,430.75; C. H. Strong & Son, Cleveland, O., $149,682.75; Frank Hefright, Huntingdon, Pa., $163,407.50; Wm. A. McCosh, Parkersburg, W. Va., $175,625; Branham & Hege, Indianapolis, Ind., $220,485.

Pumping Engines.—The Holly Manufacturing Co., of Lockport, N. Y., is constructing for the city of Lockport, a 3,000,000 galls. water power pumping engine; it is to be arranged to run either by water power or by steam, and the work will be completed in a few weeks. The company is also erecting a 20,000,000 galls. Gaskill pumping engine at the water-works of Buffalo, which will be completed and ready for service about Dec. 1, and has a contract with the city for another engine of the same size, to be put in operation next year. It is also erecting a 12,000,000 galls. Gaskill engine in the water-works pumping station at Lake, Ill., which will be completed about Dec. 1., and has completed the erection of a 12,000,000 galls. Gaskill pumping engine at the water-works of Lake View, north of Chicago; also a 3,000,000 galls. Gaskill engine at the water-works at Evanston, Ill. It has also completed the erection of a Gaskill pumping engine of 3,000,000 galls. capacity, to operate against a water pressure of 500 ft., for the water-works of San Diego, Cal., and a 5,000,000 galls. Gaskill engine for the Port Huron, Mich., water-works; also 2 engines of 250 H. P. each for the Indianapolis Water Company; these engines (Indianapolis) to be used to operate two water power pumps of 5,000,000 galls. capacity each, at times when the water power is not available; also a 15,000,000 galls. Gaskill pumping engine at the new water-works station of the American Water-Works Co., of Omaha, Neb. The company has under contract 33 pumping engines, ranging in capacity from 1,000,000 to 20,000,000 galls. daily; among which are 3 of the new design of Gaskill triple expansion engines. It is making additions to its plant, has been enlarging the old erecting shop, and will put in a new Yale & Towne crane of 15 tons capacity; this addition to the works will be completed about Dec. 1.

Bituminous Rock Paving.—The Oregon Bituminous Rock Co. has been incorporated at Portland, Ore., and plant is being manufactured in San Francisco. The rock is brought from San Luis Obispo County, Cal. The company has a capital stock of $15,000. The paving has given satisfaction in San Francisco, Los Angeles, and other Californian cities, and is expected to give good results. The *Oregonian* says, "We have had mud, corduroy planks, wooden blocks, stone blocks, gravel and macadam. And now we are to have bituminous rock, which it is claimed possesses more good qualities than any of the articles heretofore tried. The rock is of an oily, sticky nature, and when heated and rolled forms a smooth, noiseless street, free from dust."

Bridges.—The contract for building the four-span bridge for the Georgia Central Railroad over the Muscogee river has been let to the Atlanta Bridge & Axle Company, of Atlanta, Ga. The company has recently completed the following bridges for the Central system: Draw and fixed span over the Columbia river on the Blakely extension; five span across the Chattahoochee, at Columbus; one span over Walnut creek at Macon; one span over Coukee creek on the Southwestern division. The bridge over the Ocmulgee will be erected this year, and will be quite an improvement on the present structure.

A Pavement Suit in Pittsburg, Pa.—The Board of Awards, of Pittsburg, Pa., has been sued and a preliminary injunction asked for to restrain Booth & Flinn, contractors, from paving Craig St. in that city. In answer to an advertisement these contractors bid, on their own plan, $3 per sq. yd., and 88 or 38 cts. per lin. ft. for curbing (the figures 88 or 38 are not very legible and can be taken for either). The same contractors put in another bid for $2.60 and again 88 or 38 cts. for curbing. The Warren Scharf Asphalt Paving Co. bid $2.97 per sq. yd. for paving, and 75 cts. for curbing, and offered such time guarantee as the city might elect and the retention of 10 per cent. of the contract price. The Department did not award the contract on the day of opening the bids; but some time later did give it to Booth & Flinn at $3.00 per yd. under a vague and meaningless specification. It was stated that the only difference between the two bids of $2.60 and $3.00 was that the latter carried with it a 5 year repair guarantee. The Department claims that the successful bidder obtains the work by having an advantage of $1,200 in his favor in the curbing price and that the bids could not be separated.

Cables for Cable Railways.—The Broderick & Bascom Wire Rope Co., of St. Louis, Mo., has made the following deliveries of cables for street railways during the present year: Citizens Ry., 53,000 ft. long; Cable Tramway Co., Omaha, Neb., 47,000 ft.; Mt. Auburn Cable Ry., Cincinnati, O., 44,000 ft.; Missouri Ry., St. Louis, Mo., 37,000 ft.; St. Louis Cable & Western Ry., St. Louis, Mo., 35,400 ft.; Peoples Ry., Kansas City, Mo., 34,000 ft.; Cincinnati Street Ry., Cincinnati, O., 27,000 ft.

Bridges and Canals.

The Leavenworth & Platte Bridge Co. has been incorporated at Leavenworth, Kan., to build a pontoon bridge across the Misouri river. Directors, VINTON STILLINGS, J. W. FOGLE, W. B. NICOLS, J. C. LYLE and J. W. CRAMER. Capital stock, $150,000.

The Topeka Bridge Construction Co. has been incorporated at Topeka, Kan., to build a toll bridge over the Kansas river near that city; also to build other bridges. Among the directors are GEO. H. EVANS, J. B. PARNHAM R. B. KEPLEY, E. A. AUSTIN and C. E. LANE. Capital stock, $500,000.

Lake Pontchartrain Canal.—A canal is proposed at New Orleans, La., from the Mississippi river to Lake Pontchartrain, and the land has been acquired. H. DUDLEY COLEMAN, G. R. FINLAY, H. MCCLOSKEY and JAMES MCCONNELL are interested.

Bridge Centennial.—On Sept. 24 the 100th anniversary of the opening of the highway bridge between Beverly and Salem, Mass., was celebrated with considerable ceremony. The bridge is a trestle structure with a draw span, the latter having lifting leaves. It was formerly a toll bridge.

Viaducts.—*Kansas City, Kan.*—The Committee on Bridges & Viaducts has recommended with regard to the viaduct over the Union Pacific and Rock Island tracks, that the City Council enter into a contract with the two companies for the construction of the viaduct, the city to pay one-half and the two railway companies to pay the other half. The committee also decided to ask the railway companies to open 16th St., from Kansas Ave. through to the bluff, and to abandon the old southern bridge road. The viaduct will be 1,700 ft. long, 32 ft. wide, and will cost not to exceed $70,000.

Denver, Col.—D. W. C. Carroll, of Pittsburg, and Morris & Karttrell, of Chicago, have closed contracts for the building of two iron viaducts to cross the railroads. One viaduct is to be 376 ft. long and 32 ft. high, and the other 785 ft. long and 32 ft. high. The viaducts will cost $97,000, and the approaches $21,000 additional.

Railway Bridge.—*Newburyport, Mass.*—Messrs. Cofrode & Saylor, of Pittsburg, Pa., have completed a double-track deck bridge for the Boston & Maine R. R., at Newburyport, from plans prepared by THEODORE COOPER, M. Am. Soc. C. E. The total length of bridge from end to end is 1,197 ft.; consisting of one draw span of 180 ft., two fixed spans of 130 ft. and five fixed spans of 150 ft.

Omaha & Council Bluffs Bridge.—The new wagon and motor railway bridge across the Missouri river between Omaha, Neb., and Council Bluffs, Ia., was opened with appropriate ceremonies on Oct. 30.

Wabasha Street Bridge.—*St. Paul, Minn.*—The following proposals have been received for rebuilding the Wabasha St. bridge from the north abutment to the island:

M. A. O'Brien	$58,510
McMullon & Morris	55,189
P. Durock	60,059
Sherwood & Sutherland	63,964

The contract has been awarded to McMullon & Morris, of Minneapolis.

Seneca Street Bridge.—*Cleveland, O.*—The following bids for building the superstructure of the Seneca street bridge have been received by the Board of Improvements. There were five proposals, two of the bids being informal. The bidders were required to furnish figures for the 215 tons of iron and the 35,000 ft. of lumber required. The bid of the Variety Iron Works was the lowest, the price for the iron being $74.50 per ton and for lumber $30 per thousand feet. The King Iron Bridge & Manufacturing Co., of Cleveland, offered to furnish the iron for $96 per ton and the lumber for $28.50. The Detroit Bridge & Iron Works bid $105 per ton for the iron and $35 per thousand feet for the lumber. The totals are as follows:

Variety Iron Works	$17,067.50
King Iron Bridge & M'f'g Co	21,607.50
Detroit Bridge & Iron Works	23,730.00
*Pittsburg Bridge Co	26,790.00
*Shiffler Bridge Works, Pittsburg	27,052.50

*Informal.

The contract was awarded to the Variety Iron Works, of Cleveland.

The contract for the substructure has already been let at $46,000, and the engine house yet to be built will cost $5,000, making the total cost of the structure about $70,000. The plank roadway temporarily built on Canal street will probably be paid for from the bridge fund, and this, together with the advertising and other incidental expenses, will bring the outlay up to about $75,000, which is $10,000 below the estimated cost.

WATER.

New London, Conn.—The Board of Sewer Commissioners has issued its annual report for the year ending June 7, 1888. General plans for an extension of the outfall have been completed, but the work will not yet be carried out. The engineer reports that the stone drains are a menace to the health of the city. Sewer contracts have been carried out by Shaw & Whittlesey, of Providence R. I., and Jacoby & Madden, of Bridgeport, Conn.; plans have been prepared for considerable extensions. The sewers have worked satisfactorily; very little deposit having gathered, even in sewers with grades of 1 in 100 and this sediment is easily removed by occasional flushings. The contract price per ft. averaged from 75 cts. per ft. for 8 and 12-in. pipe in 7 and 5 ft. cut, to $1.50 for 12-in. pipe in 10 ft. cut; rock excavation cost $4 per cu. yd.; concrete, $5. There were 2.838 miles of public sewers with 77 connections, also 150 connections on private sewers. The opinion of the arbitrators in the matter of appeal from sewer assessments is given in full. W. H. RICHARDS is the engineer.

Portland, Ore.—In 1867 the water supply was obtained from a well dug at a spring and pumped to a reservoir by a pumping engine with a daily capacity of 300,000 galls. This amount, together with the natural flow from Balch and Caruthers creeks, supplied the city. In 1869 a new engine, with a daily capacity of 800,000 galls. was built by the Oregon Iron Works, and in 1871 a Worthington engine of 1,000,000 galls. daily capacity was added. In 1876 the present brick pumping station was built, and the Oregon Iron Works engine was replaced by another Worthington engine, with a capacity of 3,000,000 galls. per day; making the total supply from the station 4,000,000 galls. in addition to the supply from the creeks. In 1885 the company built the station known as the Palatine pumping station and put in two Worthington compound condensing engines with an aggregate daily capacity of 12,000,000 galls; the building was erected and the machinery put in under the direction of H. BLOOMFIELD, of San Francisco; this plant was started in Oct. 21, 1884. Land was also purchased for a reservoir with a capacity of 15,000,000 galls. These works cost the old Portland Water Co. between $800,000 and $900,000, and on Jan. 1, 1887, they were sold to the city for $450,000.

Water-Works.—*New York.*—Fulton. The water company will lay an additional pipe line to the present works at Oswego Falls.——Hancock. The Hancock Water Co. has been incorporated by G. A. ALLEN, FULLER DE WITT, L. E. HOWARD, of Hancock, and others. Capital stock, $12,000.——Amsterdam. The water mains are being laid across the bed of the Mohawk river.——Schenevus. The Delaware & Hudson Canal Co. will pay $800 a year for water for its locomotives. The Italians employed in trenching struck recently for an advance from $1.15 to $1.25 per day; the advance was granted. Pipe laying has been commenced.

New Jersey.—Atlantic City. The Court has decided that the Atlantic City Water-Works Co. has no exclusive franchise, and is therefore not entitled to the injunction applied for to restrain the Commissioners Water Co. from laying pipes in the streets.——Gloucester City. The water pipe system is to be extended.

Ohio.—Springfield. The water supply galleries are completed. They are 4 ft. x 5 ft., of wood, with spaces for the water to enter from the gravel formation; and they are surrounded by broken stone and gravel; they are 900 ft. long, 25 ft. below the ground and level with the bottom of the wells, and will furnish a daily supply of 2,500,000 to 2,750,000 galls. The cost was $10,000, including engine, boiler, etc. The work was done under the supervision of Superintendent BERRIMAN.

Kentucky.—Richmond. The water-works will be built by M. Philbin, of Chicago, whose contract price is $76,144.44.

Tennesee.—Johnson City. Water-works are projected. For information address the mayor.

South Carolina.—Greenville. At the vote on Oct. 22 on the proposition to issue bonds for water-works, the project was defeated by a vote of 483 to 165.

Alabama.—Troy. The wells for the new water-works will be put down by the Wagner process by the National Water Supply Co., of Cincinnati, O.

Mississippi.—Jackson. The contractor has resumed work on the water-works.

Michigan.—Albion. This place has new water-works and electric light.——Hastings. There are now 145 water-takers on the list of the Water Commissioner.——Bellaire. All the fire hydrants have now been placed in position.

Illinois.—Clinton. The city will supply the Illinois Central R. R. Co. with water at 8 cts. per 1,000 galls.——Monticello. Water-works will be built and a supply obtained from artesian wells.

Iowa.—Des Moines. The North Des Moines Water-Works Co. is laying mains and erecting its pumping station tower, etc.

Missouri.—Washington. The water company has completed its clear water basin; its capacity is 300,000 galls.

Colorado.—Montrose. Holmes & Wicks, of Colorado Springs, the contracters for the new water-works, commenced work Oct. 22. An electric light plant is projected.—Denver. The Fairbanks Co. is pushing work rapidly on the water tower and pipe laying in Eastern Capitol Hill division. The tower is 36 ft. high, with a tank 10 ft. high on top; it is located on a knoll with an elevation of about 50 ft.

California.—Pacific Grove. The Southern Pacific R. R. Co. is constructing a reservoir with a capacity of 88,000,000 galls.—Pomona. The Pomona City Water-Works Co. has been incorporated by H. J. NICHOLS, B. S. NICHOLS, L. L. PALMER, H. A. PALMER and C. M. STONE. Capital stock, $250,000.

Texas.—Greenville. The Greenville Water & Electric Light Co. has contracted with E. Sutphen, of Kansas, for the construction of water-works. There will be a stand-pipe 135 ft. high.

Allentown, Pa.—The Water Commissioners have issued their annual report for the year ending Dec. 31, 1887. During the year the Fountain House property was purchased for the new water-works, and arrangements

Analyses of Well Water.—The following table gives the results of analyses of water from wells at Orlando, Fla., made by Prof. THOS. R. BAKER in August. The water is said to have a somewhat disagreeable odor at times due to hydrogen-sulphide gas, however, is harmless; the quality of the water is said to be excellent.

Number.	Source.	Depth of well, feet.	Age of well, years.	Parts in 100,000.		Grains in U. S. Gal.		Nitrates.
				Free Ammonia.	Alb'minoid Ammonia.	Chlorine.	Total solids.	
1	Ice factory, condensed water			.008	.000	0.000	1.042	None.
2	Robert Howe's open well	15	10	Trace.	.015	9.173	2.502	None.
3	G. T. Gilreath's open well	8	8	Trace.	.031	13.342	5.836	Large.
4	Orlando water company			.003	.026	5.838	2.919	None.
5	Dr. Dickenson's drive well	27	1½	Trace.	Trace.	7.506	3.336	None.
6	Church st., near Orange av., drive well	28	3	.019	.031	8.340	7.923	Small.
7	John A. Dollins' drive well	27	2	.004	.022	6.672	3.336	None.
8	C. G. Lee's drive well	14	1½	Trace.	.011	5.838	4.170	None.
9	W. L. Siemons' drive well	18	2	None.	.008	5.838	2.502	None.
10	T. R. Baker's drive well	21	¾	.000	.010	7.506	3.336	None.
11	W. Grimm's drive well	28½	4	Trace.	.010	6.672	3.336	None.
12	Ice factory, open well	16	5	None.	.008	14.178	4.170	None.

made for enlarging the works, laying new supply pipes, putting in new pumps and doing other work. Two Knowles pumping engines of 3,000,000 galls. capacity each, were contracted for; the 20-in. supply pipe was obtained of R. D. Wood & Co., of Philadelphia; and the contract for a new stand-pipe was awarded to Tippett & Wood, of Phillipsburg, N. J. There were 9,383 ft. of pipe laid, 16 hydrants and 23 stop valves set. SAMUEL S. THOMPSON is Superintendent.

Newark, N. J.—EDWARD ADAM, City Surveyor, has issued his report for 1887, giving the work done and cost for same. The city has considerable granite block paving and Telford paving. Of new sewer 6.71 miles were built. The intercepting sewer which was commenced in December, 1884, was completed Nov. 1; from that date to the end of the year the average amount of sewage pumped (6 sewers emptying into the intercepting sewer) was 6,000,000 galls. per day; the maximum being 16,000,000 galls. during a rainstorm; J. S. SCHAEFFER was the engineer for this sewer. The dredging at the sewer outlets in the Passaic river was done by Ross & Sanford at 70 cts. per cu. yd., scow measurement. There are tables of contracts and of city work carried out.

Menomonee, Wis.—The water-works system consists of two duplex pumping engines, with a daily capacity of 1,500,000 galls., working at a pressure of from 70 to 90 lbs. per sq. in., and a stand-pipe with a capacity of 200,000 galls. There are 8 miles of mains, with 106 double nozzle hydrants. Stand-pipe pressure is used for the ordinary supply, but direct pumping pressure can be applied and a supply of water drawn from the river for fire purposes. In addition to the city water-works, Knapp, Staut & Co. have a reservoir with a capacity of 160,000 galls., situated at an elevation which would give a pressure of about 85 lbs., and this water could be utilized in case of fire near the mills.

Galveston, Tex.—The Committee on Water has received the following proposition from the Galveston Water Co., and has renewed the contract on the terms stated therein: To lease the water-works plant until the first of April, 1889, upon the same terms of the last contract, which expires to-day (October 15, 1888), provided the city shall pay for the replacing of pavements torn up in taking up the water mains of this company, whenever it may so desire, after the expiration of this renewal. Said company to pay for all filling of excavations made in the removing of said mains. The removal of the pipes on the paved streets to be done under the supervision of the city engineer.

The Jeter & Boardman Water & Gas Works Association, Macon, Ga., has increased its capital stock from $200,000 to $400,000 in order to enlarge its operations. The association is now building water-works at several places in the South.

New York City.—The Farmers Loan & Trust Co. was the highest bidder on October 31, for $1,000,000 of the city's water stock and $500,000 of dock bonds, payable, respectively in 1907 and 1909 and drawing 3 per cent. interest. Its bid for the stock was 108.31 and for the bonds 110.59. The stock and bonds were awarded to it.

Iquique, Peru.—The municipality has approved the report of the committee appointed to examine into and report upon the water supply, dated July 23, 1888, and the supplementary report dated Aug. 1. The concessions granted to Thomas Hart under the act of Jan. 23, 1885, and Feb. 9, 1886, have now lapsed, and are declared forfeit by the municipality. The Tarapaca Water-Works Co., which had acquired these concessions and whose project has before been mentioned in ENGINEERING NEWS, will now have to compete with four other contractors who desire to undertake to establish a water supply for the city, and whose propositions will be considered by the municipality.

The Cedar Valley Water Co. has been incorporated at Seattle, Wash. Ty., with a capital stock of $100,000, by W. H. MURRAY and A. ASHDOWN, of San Francisco, and J. FRINK, H. A. RAY and L. A. TREEN, of Seattle. The company will contract for the establishment of water-works, electric light plant, etc.

Grand Rapids, Mich.—The Board of Public Works has submitted its report for the year ending April 30, 1888. There are 28 miles of water mains, 296 hydrants and 193 valves. The amount of water pumped was 1,013,576,200 galls. A connection has been made with the river for a supply in case of emergency. Iron pipe is being substituted for wood. There are 17.468 miles of brick sewers, 21.660 miles of glazed pipe sewers, .480 mile of cement sewer, 1.853 mile of wood sewers, .160 mile of iron sewer pipe in the river. H. A. COLLAR is City Engineer.

Jersey City, N. J.—The Water Committee has made the following report to the Board of Works: Your committee to whom were referred the bids received by this Board for supplies of pure and wholesome water, and for a system of purifying and filtering the present water supply of this city, would respectfully report that after due consideration of the same, they have come to the conclusion that it would not be advantageous to the city to purchase plant for the filtration of the water for the reason that the cost of the same is too great, and that they fear the result of such an expensive experiment is too uncertain, and would recommend that the city purchase a supply of pure and wholesome water.

Special Reports of Water-Works Construction.

THE ENGINEERING NEWS MANUAL OF AMERICAN WATER-WORKS is now being compiled, and will be *indispensable* to every manufacturer, engineer and contractor in any way interested in Water-Works construction and maintenance, and will be of great value to Water-Works superintendents and projectors of new works.

Superintendents of water-works and water companies will wish to see correct and complete data concerning their Works in our MANUAL, and to ensure this they should send in reports *at once* upon the blanks which we have already sent to every Water-Works office in the United States and Canada. Many have delayed their report, and if the blanks we intended for them have been lost in the mail, or mislaid, we will send more upon request.

We *must* have a report from every public water supply system in North America, so those who reply to our inquiries at once will save a second inquiry. We also wish to know of *every* new Water-Works plant in process of construction, and of *every* new project in this line. We will send to any one desiring them, blanks upon which reports can be made.

Further details of the MANUAL will be advertised later. We abstract from our special reports for the MANUAL the following items of current interest:

BRIDGEPORT, Pa., Oct. 27, 1888.

EDITOR ENGINEERING NEWS:—The Bridgeport Water Co. proposes to pump water from Schuyler's river to a reservoir, the estimated cost of completed works being $70,000. The engineers for the company are Powell & Middleton, 327 New St., Philadelphia. The present supply is from wells, and the population is 3,000.

I. BARTHOLOMEW.

DERBY STATION, Oct. 27, 1888.

EDITOR ENGINEERING NEWS:—I have your letter with inclosures of the 24th inst. Replying to give a brief general description of the Greensburg water system, I would say that the line embraces in the neighborhood of 21 miles of main running from the source of supply at the Chestnut ridge (a chain of hills running parallel and subordinate to the Allegheny mountains) 11 miles northwest to Greensburg, on past that place west through Grapeville to Jeannette, a new town, on to Penn Manor and terminating at Irwin. Grapeville is a very small unimportant station on the railroad, 1 mile east of Jeannette. The wet weather has prevented operations thus far on the line west of the town of Greensburg, but water is expected at the latter place this season.

The law in Pennsylvania requires a company for each political division of borough and township, hence the different companies given below, though they are practically one and the same.

There are to be four reservoirs on the entire line, two east of Greensburg, one of which is estimated to hold 150,000,000 galls. and is situated on the Chestnut Ridge; the other 12,000,000 galls., and is located three miles from Greensburg; and the two reservoirs west of Greensburg, which will have a capacity of about 75,000,000 and 10,000,000 galls.

The names of the companies embraced in the lines are: The Westmoreland Water Co., of Unity Township, of Hempfield Township, of Greensburg, (Borough), of Ludwick, (Borough), the Penn Township Water Co., the Penn Borough Water Co., the North Huntington Water Co., (Township), and the Irwin Water Co.

MURRAY FORBES.

SUMTER, S. C., Oct. 28, 1888.

EDITOR ENGINEERING NEWS.—No water-works yet. Hope to have them soon. Address J. A. WOOD, Mayor. D. J. AUDD.

WAYCROSS, Ga., Oct. 25, 1888.

EDITOR ENGINEERING NEWS:—Estimates are being made for water-works for Waycross. Address E. H. CROWLEY, or J. L. SWEAT. A. H. MORGAN.

CHATTANOOGA, Tenn., Oct. 26, 1888.

EDITOR ENGINEERING NEWS:—We are now laying 12-in. pipe out to Ridgedale, East Lake and East End, suburbs of this city, to cover the ground intended to be occupied by the Spring Lake Water Co. Have made contracts which virtually shut out the new company for some time to come. This extension is five miles in length. NISBET WINGFIELD, *Supt.*

BILOXI, Miss., Oct. 26, 1888.

EDITOR ENGINEERING NEWS:—We have no water works yet, but there is a good opening for a live company to build some. There has been talk of starting a stock company. A flow of 60 galls. of water of the purest kind to the minute can be obtained by boring 500 ft. Information will be furnished by the undersigned.

L. B. HOLLEY.

RIPON, Oct. 27, 1888.

EDITOR ENGINEERING NEWS:—The Council have been trying to put in works but have not succeeded.

SPOKANE FALLS, Wash. T., Oct. 21, 1888.

EDITOR ENGINEERING NEWS:—We are about to commence the construction of new water-works which will cost about $100,000. R. A. JONES, *Supt.*

RENO, Nev., Oct. 22, 1888.

EDITOR ENGINEERING NEWS:—There is talk of another water company being established here by WM. THOMPSON. J. C. HEGEMAN.

RECORD OF NEW WATER-WORKS CONSTRUCTION.

(Specially communicated).

CONTINUED FROM PAGE 388.

Sandy Hill, N. Y.—The works were commenced in July, 1888, and completed in October, 1888. They were designed by R. W. SHERMAN, City Engineer of Utica, N. Y., and W. B. RIDER, of South Norwalk, Conn., was Constructing Engineer. The contractors were Sherman & McDonough, of Troy, N. Y., and the stand-pipe was built by the Porter Mf'g. Co., of Syracuse, N. Y.; Ludlow valves and Mathews hydrants are used. The supply is taken from springs and pumped to a steel stand-pipe 18 ft. diameter and 12 ft. high, with a total head of 161 ft., by two compound duplex Worthington pumping engines, with a daily capacity of 750,000. There are 5½ miles of pipe, 43 hydrants and 60 taps; the mains are of cast-iron and the services of lead and iron. Ordinary pressure, 50 lbs.; fire pressure, 50 to 100 lbs. Cost of works, $60,000. Annual revenue; about $1,500 from consumers for first year, and $2,500 from city. The franchise is for 10 years, and the village pays $2,500 per annum for 40 hydrants. The works are owned by the Spring Brook Water Co; President and Superintendent, JOHN J. CUNNINGHAM; Treasurer, R. W. SHERMAN; Secretary, JAMES E. FLOOD; capital stock, $70,000. The present population is about 3,000 (Date of special report; September 28, 1888).

Decatur, Ala.—The works were commenced in September, 1887, and were to be completed in August, 1888. At the time of our special report (June 11, 1888), 15 miles of pipe had been laid and the stand-pipe and buildings were under construction. They were designed by Howland & Ellis, Boston, Mass., who also took the contract for construction, and did the buildings, foundations, trenching and pipe laying. The pumping machinery was supplied by the Deane Steam Pump Co., of Holyoke, Mass.; the pipes and specials by Dennis, Long & Co., of Louisville, Ky.; the valves and hydrants by the Chapman Valve Mf'g. Co., of Boston, Mass.; and the stand-pipe by Tippett & Wood, of Phillipsburg, N. J. The river intake was laid by Thacher & Breymann, of Toledo, O. The supply is taken from the Tennessee river and pumped to stand-pipe 20 ft. diameter and 120 ft. high, by a horizontal, duplex, high pressure, condensing pumping engine, with a daily capacity of 5,000,000 galls.; direct pumping can also be used. There are 38 to 40 miles of pipes and 380 hydrants; the mains are of cast-iron, and the service pipes of wrought-iron. Ordinary pressure, 55 lbs.; fire pressure, 100 lbs. Cost of works, $600,000; debt, $300,000; rate of interest, 6 per cent. The franchise is for 20 years and the hydrant rental is $50 each per annum for the first 100, $40 for the second 100, and $30 each for all over 200. The works are owned by the Decatur Water Co.; President, JOHN D. ROQUEMORE; Secretary, W. F. ELLIS, Jr.; Treasurer, C. C. HARRIS; General Manager, A. A. HOWLAND. Stock, $350,000; bonds, $350,000. The present population is estimated at about 10,000.

TO BE CONTINUED.